

DRAFT

Programmatic Environmental Assessment

for

Fisheries Research Conducted and Funded by the Northwest Fisheries Science Center

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LIST OF ACRONYMS AND ABBREVIATIONS

ABC	Acceptable Biological Catch
ADCP	Acoustic Doppler Current Profiler
BIOPS	Biological Opinions
BRD	Bycatch Reduction Device
CCF	California Current Front
CCRA	California Current Research Area
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CINMS	Channel Islands National Marine Sanctuary
CPS	Coastal Pelagic Species
CRERA	Columbia River Estuary Purse Seining
CRITFC	Columbia River Inter-Tribal Fish Commission
CS	Chief Scientist
CTD	Conductivity Temperature Depth
CZMA	Coastal Zone Management Act
DAS	Days at Sea
DCF	Davidson Current Front
DPEA	Draft Programmatic Environmental Assessment
DPS	Distinct Population Segment
EA	Environmental Assessment
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
ESA	Endangered Species Act
ESU	Evolutionarily Significant Units
FMC	Fishery Management Council
FMP	Fishery Management Plan
FONSI	Finding of No Significant Impact
FRAM	Fishery Resource Analysis
FWCA	Fish and Wildlife Coordination Act
HAPC	Habitat Areas of Particular Concern
HMS	Highly Migratory Species
IATTC	Inter-American Tropical Tuna Commission
IPHC	International Pacific Halibut Commission

IDCP	International Dolphin Conservation Program
IDCPA	International Dolphin Conservation Program Act
IHA	Incidental Harassment Authorization
IMO	International Maritime Organization
ITS	Incidental Take Statements
IWC	International Whaling Commission
LME	Large Marine Ecosystems
LNG	Liquid Natural Gas
LOA	Letters of Authorization
LOF	List of Fisheries
LCRRA	Lower Columbia River Research Area
MBTA	Migratory Bird Treaty Act
MMED	Marine Mammal Excluder Device
MMPA	Marine Mammal Protection Act
MOU	Memorandum of Understanding
MPRSA	Marine Protection Research and Sanctuaries Act
MSA	Magnuson-Stevens Fishery Conservation and Management Act
M&SI	Mortality and Serious Injury
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NMSA	National Marine Sanctuaries Act
NOAA	National Oceanic and Atmospheric Administration
NPFMC	North Pacific Fishery Management Council
NPS	National Park Service
NWFOP	Northwest Fisheries Observer Program
NWFSC	Northwest Fisheries Science Center
NWTRC	Northwest Testing Range Center
OCNMS	Olympic Coast National Marine Sanctuary
ODFW	Oregon Department of Fish and Wildlife
OFL	Overfishing Limit
OPR	Office of Protected Resources
PBR	Potential Biological Removal
PCB	Polychlorinated Biphenyl
PICES	North Pacific Marine Sciences Organization

POCTRP	Pacific Offshore Cetacean Take Reduction Plan
PFMC	Pacific Fishery Management Council
PSC	Pacific Salmon Commission
PSMFC	Pacific States Marine Fisheries Commission
PSO	Protected Species Observers
PSRA	Puget Sound Research Area
PSTA	Pacific Salmon Treaty Act
RFFA	Reasonably Foreseeable Future Actions
SAF	Subarctic Front
SAR	Stock Assessment Report
SSF	Shelf Slope Front
SMCA	State Marine Conservation Area
SMP	State Marine Park
SMR	State Marine Reserves
SOC	Species of Concern
SRKW	Southern Resident Killer Whale
SWFSC	Southwest Fisheries Science Center
UNEP	United Nations Environmental Program
U.S.	United States
USC	United States Code
USFWS	United States Fish and Wildlife Service
WDFW	Washington Department of Fish and Wildlife

EXECUTIVE SUMMARY

CHAPTER 1 – INTRODUCTION AND PURPOSE AND NEED

The federal government has a responsibility to conserve and protect living marine resources in waters of the United States (U.S.), also referred to as federal waters. These waters generally lay 3 to 200 nautical miles (nm) from the shoreline, and comprise an area known as the Exclusive Economic Zone (EEZ)¹. The National Oceanic and Atmospheric Administration (NOAA) has the primary responsibility for managing marine finfish and shellfish, certain marine mammal species, sea turtles in marine waters, and their habitats. Within NOAA, the National Marine Fisheries Service (NMFS) has been delegated primary responsibility for the science-based management, conservation, and protection of living marine resources within the U.S. EEZ.

NMFS is fundamentally a science-based agency, with its primary mission being the stewardship of living marine resources through science-based conservation and management. So central is science-based management to NMFS fishery management efforts, it is listed among the ten National Standards set forth in the Magnuson-Stevens Fishery Conservation and Management Act (MSA): “(2) Conservation and management measures shall be based upon the best scientific information available.” (16 U.S.C. §§ 1801-1884).

This Draft Programmatic Environmental Assessment (DPEA) evaluates both a primary and a secondary federal action under the National Environmental Policy Act (NEPA). The purpose and need for the primary action is to continue fisheries research activities conducted and funded by the Northwest Fisheries Science Center (NWFSC) to produce scientific information necessary for the management and conservation of living marine resources in the Pacific Ocean and tidal waters of Puget Sound and the Lower Columbia River. This research promotes both the recovery of certain species and the long-term sustainability of these resources. It also generates social and economic opportunities and benefits from their use. The information developed from these research activities is essential to the development of a broad array of fisheries, marine mammal, and ecosystem management actions taken not only by NMFS, but also by other federal, tribal and state authorities. Each of the research activities requires one or more scientific research permits and the issuance of these permits is a part of the primary federal action covered under this NEPA review. The secondary action is the issuance of proposed regulations and subsequent Letters of Authorization (LOA) under Section 101(a)(5)(A) of the Marine Mammal Protection Act (MMPA) of 1972, as amended (MMPA; 16 United States Code [U.S.C.] 1361 et seq.) that would govern the unintentional taking of small numbers of marine mammals incidental to NWFSC fisheries research activities.

Fisheries Science Centers

In order to direct and coordinate the collection of scientific information needed to make informed fishery conservation and management decisions, NMFS established six Regional Fisheries Science Centers², each a distinct organizational entity and the scientific focal point within NMFS for region-based federal fisheries-related research in the United States.

¹ An Exclusive Economic Zone is an area over which a nation has special rights over the exploration and use of marine resources.

² Northeast FSC, Southeast FSC, Southwest FSC, Northwest FSC, Alaska FSC, and Pacific Islands FSC.

The Fisheries Science Centers conduct primarily fisheries-independent research studies³ but may also participate in fisheries-dependent and cooperative research studies. This research is aimed at monitoring fish stock recruitment, survival and biological rates, abundance and geographic distribution of species and stocks, and providing other scientific information needed to improve our understanding of complex marine ecological processes and promote NMFS strategic goal of ecosystem-based fisheries management.

Northwest Fisheries Science Center Research Activities

Until recently, the NWFSC provided scientific support for NMFS Northwest Region while the Southwest Fisheries Science Center (SWFSC) provided scientific support for NMFS Southwest Region. In the fall of 2013, NMFS merged the Northwest and Southwest regional offices into a single administrative unit, the West Coast Region. However, the NWFSC and SWFSC remain separate research institutions which independently contribute scientific information to the West Coast Region, although they frequently collaborate and have overlapping geographical research areas. The NWFSC conducts research primarily in U.S. marine waters from Canada to Mexico, including estuaries and freshwater systems of Puget Sound and the major rivers in Washington and Oregon. The NWFSC contributes scientific data for fisheries and marine resource management issues to the West Coast states, Pacific Fishery Management Council, Pacific Salmon Commission, Pacific States Marine Fisheries Commission, Native American tribal governments, stakeholder groups, and several international fisheries management organizations. The Pacific Fishery Management Council has jurisdiction for developing fishery recommendations that cover non-treaty fisheries in the exclusive economic zone off Washington, Oregon and California.

In addition to fisheries management organizations, NWFSC generates and communicates scientific information to support the restoration of Pacific coastal rivers and estuaries, the recovery of protected species, the establishment of marine protected areas, the emergence of marine spatial planning, and to advance scientific understanding of the structure and function of marine ecosystems and the impacts of climate change on these systems.

The specimen archives collected during NWFSC research cruises include some of the world's preeminent collections of plankton, fish, marine invertebrates, and tissue samples for molecular genetics. Sample coverage from different coastal areas is unique in the world because of the long time-series and extensive area from which they have been sampled. These collection archives provide an important record of species diversity, community composition, genetic structure, and an extraordinary record of climate change and other human impacts for current and future studies.

NMFS has prepared this DPEA to evaluate several alternatives for conducting and funding these fisheries and ecosystem research activities as the primary federal action. NMFS is also evaluating a number of mitigation measures that may be implemented to reduce potential impacts on marine mammals as part of the analysis concerning the secondary action, compliance with the MMPA. Additionally, because the proposed fisheries and ecological research activities occur in areas inhabited by a number of marine mammals, birds, sea turtles, and fishes listed under the Endangered Species Act (ESA) as threatened or endangered, this DPEA evaluates activities that could result in unintentional impacts on ESA-listed marine species.

³ Fisheries-independent research is designed and conducted independent of commercial fishing activity to meet specific research goals, and includes research directed by NWFSC scientists and conducted on board NOAA- owned and operated vessels or NOAA-chartered vessels. Fisheries-dependent research is research that is carried out in partnership with commercial fishing vessels. The vessel activity is not directed by the NWFSC, but researchers collect data on the commercial catch. Cooperative research programs are those where the NWFSC provides substantial support of the research through funding, equipment supply, or scientific collaboration but which are carried out by cooperating scientists (other agencies, academic institutions, commercial fishing-associated groups, or independent researchers) on board non-NOAA vessels.

CHAPTER 2 – ALTERNATIVES

The National Environmental Policy Act requires federal agencies to consider alternatives to a proposed federal action. The evaluation of alternatives under NEPA assists the decision maker in ensuring that any unnecessary impacts are avoided through an assessment of alternative ways to achieve the underlying purpose of the proposed action that may result in less environmental harm.

To warrant detailed evaluation under NEPA, an alternative must be reasonable and meet the stated purpose and need for the proposed actions (see Section 1.3). Additionally, NEPA requires consideration of a “no action” alternative, which is Alternative 1 in this DPEA. NMFS has applied the following screening criteria to a range of alternatives to identify which ones should be brought forward for detailed analysis:

Screening Criteria

To be considered “reasonable” for purposes of this DPEA, an alternative must meet the following criteria:

- The action must not violate any federal statute or regulation.
- The action must be consistent with reasonably foreseeable funding levels.
- The action must be consistent with long-term research commitments and goals to maintain the utility of scientific research efforts, or consider no federal funding availability for fisheries research.

To maintain the utility of scientific research efforts, fisheries and marine ecosystem scientific research should address at least some of the following goals related to fisheries management:

- Methods and techniques should provide standardized and objective data consistent with or complementary to past data sets (time-series) in order to facilitate long-term trend analyses.
- Collected data should adequately characterize living marine resource and fishery populations and the health of their habitats.
- The surveys should enable assessment of population status and provide predictive capabilities required to respond to changing ecosystem conditions and manage future fisheries.
- Research on new methodologies to collect fisheries and ecosystem information (e.g. active and passive acoustic instruments and video surveys of benthic habitats in lieu of bottom trawl gear) and research oriented toward modifications of fishing gear to address bycatch or other inefficiencies should be conducted under experimental conditions sufficient to allow statistically valid comparisons with relevant alternatives.

NMFS evaluated each potential alternative against these criteria. Based on this evaluation, the No-Action/Status Quo Alternative and two other action alternatives have been identified as reasonable and were carried forward for more detailed evaluation in this DPEA. NMFS also evaluated a second type of no-action alternative that considers no federal funding for fisheries research activities. This has been called the No Research Alternative to distinguish it from the No-Action/Status Quo Alternative. The No-Action/Status Quo Alternative was used as the baseline to compare all of the other alternatives.

Three of the alternatives include a program of fisheries and ecosystem research projects conducted or funded by the NWFSC as the primary federal action. Because this primary action is connected to a secondary federal action (also called a connected action under NEPA), for NMFS to consider promulgation of regulations and subsequent issuance of LOAs under Section 101(a)(5)(A) of the MMPA for the incidental, but not intentional, taking of marine mammals, NMFS must identify as part of this evaluation under the MMPA “(t)he means of effecting the least practicable adverse impact on the species or stock and its habitat”. As a result, NMFS has identified and evaluated a reasonable range of mitigation

measures to minimize impacts to marine mammals that occur in NWFSC research areas. In addition, because this NEPA document will be used to initiate section 7 consultation under the ESA and for compliance with other conservation laws, each of which may recommend or require mitigation measures, the consideration of mitigation measures is extended to all protected species. These mitigation measures are considered as part of the identified alternatives in order to evaluate their effectiveness to minimize potential adverse environmental impacts. Protected species include all marine mammals, which are covered under the MMPA, all species listed under the ESA, and bird species protected under the Migratory Bird Treaty Act.

In addition, under all three action alternatives, the NWFSC would continue to apply to the NMFS West Coast Region for receipt of Scientific Research Permits (SRPs) for research that will affect species regulated under the MSA and ESA section 10 permits for directed research on all ESA-listed species. While this DPEA may not provide all the information needed to complete these permit processes, it provides a programmatic overview of the NWFSC research program in marine waters that provides useful context for those permit efforts. Also, because the proposed research activities occur partially within the boundaries of National Marine Sanctuaries, and within areas identified as Essential Fish Habitat (EFH), this DPEA evaluates potential impacts to sanctuary resources and EFH as required under section 304(d) of the National Marine Sanctuaries Act and section 305(b)(2) of the MSA respectively.

Alternative 1 - No-Action/Status Quo Alternative - Conduct Federal Fisheries and Ecosystem Research with Scope and Protocols Similar to Past Effort

The No-Action/Status Quo Alternative includes fisheries research using the same protocols as were implemented in the recent past (considered to be from 2008 through 2014 for the purposes of this DPEA). These federal research activities are necessary to fulfill NMFS mission to provide science-based management, conservation, and protection of living marine resources in the areas of the Pacific Ocean, Puget Sound, and the Lower Columbia River covered by the NWFSC. Under Alternative 1, the NWFSC would use the same scope of research as in recent years and with current mitigation measures for protected species.

Under the Status Quo Alternative, the NWFSC would administer and conduct a wide range of fishery-independent and industry-associated research and survey programs, as summarized in Table 2.2-1. These surveys generally use fishing gear to capture fish and invertebrates for stock assessment or other research purposes, and also include collection of plankton and larval life stages and oceanographic and acoustic data to characterize the marine environment. The main gear types of concern for potential interactions with protected species include bottom trawls, pelagic trawls (surface and mid-water), purse seines, tangle nets, and various hook-and-line gears (including longline, rod and reel, and trolling deployments). In addition, the use of certain acoustic instruments and the presence of researchers may lead to behavioral harassment of marine mammals. The scope of past research activities is considered as the basis for analysis of future activities under the Status Quo Alternative.

The Status Quo Alternative research activities include a suite of mitigation measures that were developed to minimize the risk of ship strikes and captures of protected species in fishing gear (i.e., marine mammal Take Reduction Plans). The following mitigation measures have been implemented on all NWFSC surveys since at least the end of 2013, although many surveys implemented them earlier:

- Visual monitoring for protected species prior to deployment of gear;
- Use of the “move-on” rule if marine mammals are sighted from the vessel prior to deployment of trawl, hook-and-line, purse seine, or any other fishing gear that may pose a risk of interactions with protected species and if the animals appear to be at risk of interaction with the gear as determined by the professional judgment of the Chief Scientist or officer on watch; and
- Short tow times and set times to reduce exposure of protected species to research gear.

However, these mitigation measures may not be sufficient to reduce the effects of NWFSC fisheries research activities on marine mammals to the level of least practicable adverse impact, as required under the MMPA (see Alternative 2). Other mitigation measures may be required under the MMPA and ESA processes for the specified research activities conducted by the NWFSC.

Alternative 2 – Preferred Alternative - Conduct Federal Fisheries and Ecosystem Research (New Suite of Research) with Mitigation for MMPA and ESA Compliance

The Preferred Alternative includes a combination of research activities continued from the past and additional, new research surveys and projects as described in Table 2.3-1. Under this alternative, the NWFSC would apply to NMFS Office of Protected Resources (OPR)⁴ to promulgate regulations governing the issuance of LOAs for incidental take of marine mammals under the MMPA. OPR would consider these activities and mitigation measures and determine whether it should promulgate regulations and issue LOAs as appropriate to the NWFSC. If regulations are promulgated and LOAs are issued, they would prescribe: the permissible methods of taking; a suite of mitigation measures intended to reduce the risk of potentially adverse interactions with marine mammals and their habitats during the specified research activities.

In addition, the NWFSC has engaged in ESA Section 7 consultations with NMFS West Coast Regional Office (and U.S. Fish and Wildlife Service) for species that are listed as threatened or endangered. These consultations will result in the development of a Biological Opinion (BiOp) that describes the determinations of NMFS whether or not the primary and secondary federal actions are likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of any critical habitat. The BiOp may contain incidental take statements for ESA-listed species that include reasonable and prudent measures along with implementing terms and conditions intended to minimize the number and impact of incidental takes of ESA-listed species during NWFSC research activities; and monitoring and reporting requirements.

The Preferred Alternative also includes the same suite of mitigation measures as the Status Quo Alternative to reduce the risk of adverse interactions with protected species. In addition, there are several gear modifications that the NWFSC would implement under the Preferred Alternative that would further mitigate or help monitor interactions with protected species, particularly marine mammals. The mitigation measures considered under the Preferred Alternative are intended to reduce the effects of NWFSC fisheries research activities on marine mammals to the level of least practicable adverse impact, as required under the MMPA.

- The NWFSC is currently working to develop a marine mammal excluder device (MMED) that will be incorporated into the Nordic 264 surface trawl net used for the Juvenile Salmon PNW Coastal Survey. This device is a rigid grate with a set of bars across the cod end of the net and an escape hatch just forward of this set of bars (Appendix A). Recent experiments have used video cameras attached to the net opening and near the excluder device to test different configurations of the excluder device to minimize loss of target species. Additional research will be necessary to calibrate catch levels in tows with the excluder device compared to past tows that did not contain the excluder (i.e., to align the new catchability rates with historical data sets). During these configuration and calibration experiments some nets will be fished without the MMED in order to provide controls for catchability. Once the NWFSC completes these experiments the MMED will be used in all future trawls with this net. The NWFSC will use high-resolution video cameras on all tows made with the MMED both to evaluate effects of the MMED on catch and to determine

⁴ Permits and Conservation Division, Incidental Take Program

if marine mammals enter the net undetected by observers and either escape on their own by swimming out of the net or through the MMED. All video data will be digitally recorded and reviewed at a later date.

- For the Pair Trawl Columbia River Juvenile Salmon Survey, experimental development of large flexible antenna housings for PIT-tag detection was begun in 2013. The NWFSC is testing the potential to replace the pair trawl net with a matrix of such large coiled antennas towed at high speed. There would be virtually no potential for marine mammal interactions with such a mobile, flexible PIT-tag detection system.

The NWFSC considers the current suite of monitoring and operational procedures to be necessary to minimize adverse interactions with protected species and still allow the NWFSC and its cooperating partners to fulfill their scientific missions. However, some mitigation measures such as the move-on rule require judgments about the risk of gear interactions with protected species and the best procedures for minimizing that risk on a case-by-case basis. Ship captains and Chief Scientists are charged with making those judgments at sea. They are all highly experienced professionals but there may be inconsistencies in how those judgments are made across the range of research surveys conducted and funded by the NWFSC. In addition, some of the mitigation measures described in the Status Quo Alternative could also be considered “best practices” for safe seamanship and avoidance of hazards during fishing (e.g., prior surveillance of a sample site before setting trawl gear). At least for some of the research activities considered in this DPEA, explicit links between the implementation of these best practices and their usefulness as mitigation measures for avoidance of protected species have not been formalized and clearly communicated with all scientific parties and vessel operators. The NWFSC therefore proposes a series of improvements to its protected species training, awareness, and reporting procedures under the Preferred Alternative. The NWFSC expects these new procedures will facilitate and improve the implementation of the mitigation measures described under the Status Quo Alternative.

- Under the Preferred Alternative, the NWFSC will initiate a process for its Chief Scientists and vessel captains to communicate with each other about their experiences with protected species interactions during research work with the goal of improving decision-making regarding avoidance of adverse interactions. As noted in the Status Quo Alternative description of mitigation measures, there are many situations where professional judgment is used to decide the best course of action for avoiding protected species interactions before and during the time research gear is in the water. The intent of this training measure would be to draw on the collective experience of people who have been making those decisions in order to introduce consistency in decision-making, provide a forum for the exchange of information about what went right and what went wrong, and try to determine if there are any rules-of-thumb or key factors to consider that would help in future decisions regarding avoidance practices. The NWFSC would coordinate not only among its staff and vessel captains but also with those from other NMFS Fisheries Science Centers with similar experience.
- Another new element of the Preferred Alternative is the proposed development of a formalized protected species training program for all crew members that would be required for all NWFSC research projects, including cooperative research partners. Training programs would be conducted on a regular basis and would include topics such as monitoring and sighting protocols, species identification, decision-making factors for avoiding take, procedures for handling and documenting protected species caught in research gear, and reporting requirements. The NWFSC will work with the Northwest Fisheries Observer Program (NWFOP) to develop a protected species training program and materials for all appropriate scientists and crew. The implementation of this training program would formalize and standardize the information provided to all crew that might experience protected species interactions during research activities.

- For all NWFSC-affiliated research projects and vessels, written cruise instructions and protocols for avoiding adverse interactions with protected species will be reviewed and, if found insufficient, made fully consistent with any guidance on decision-making that arises out of training opportunities.
- The NWFSC will incorporate specific language into its contracts that specifies all training requirements, operating procedures, and reporting requirements for protected species that will be required for all charter vessels and cooperating research partners.

Alternative 3 - Modified Research Alternative – Conduct Federal Fisheries and Ecosystem Research (New Suite of Research) with Additional Mitigation

Under Alternative 3, the NWFSC would conduct and fund the same scope of fisheries research as described in the Preferred Alternative and would include all of the same mitigation measures considered under the Preferred Alternative. Under this alternative, the NWFSC would also apply for authorizations under the MMPA for incidental take of protected species during these research activities and initiate section 7 consultations regarding ESA-listed species. The difference between Alternative 3 and the Preferred Alternative is that Alternative 3 includes a number of additional mitigation measures derived from a variety of sources including: (1) comments submitted from the public on potential mitigation of commercial fisheries impacts, (2) discussions within NMFS OPR as part of the proposed rulemaking process under the MMPA, and (3) a literature review of past and current research into potential mitigation measures. These measures include changes to visual monitoring methods for protected species (e.g., dedicated Protected Species Observers and technological methods to improve detection under poor visibility conditions), operational restrictions on where and when research may be conducted, and adoption of alternative methodologies and equipment for sampling.

The NWFSC regularly reviews its procedures and investigates options for incorporating new mitigation measures and equipment into its ongoing survey programs. Evaluating new mitigation measures includes assessing their effectiveness in reducing risk to protected species, but measures must also pass safety and practicability considerations, meet survey objectives, allow survey protocols to remain compatible with previous data sets, and be consistent with the purpose and need for NWFSC research activities. Some of the mitigation measures considered under Alternative 3 (e.g., no night fishing or broad spatial/temporal restrictions on research activities) would not allow survey protocols to remain consistent with previous data sets and would essentially prevent the NWFSC from collecting data required to provide for fisheries management purposes under the MSA. Some research surveys necessarily target fish species that are preyed upon by protected species with an inherent risk of interactions during these surveys. The NWFSC acknowledges the inherent risk of these surveys and it has implemented a variety of measures to help mitigate that risk. However, the experimental design of many surveys includes the need to sample “hotspots” of marine life, which often include protected species drawn to concentrations of fish and invertebrates. If these surveys could not sample in areas rich in marine life, as indicated by the presence of marine mammals, even if the protected species did not appear to be at risk of interaction with the research gear, the sampling results would not accurately reflect the variability in abundance for different fish species and the ability of the NWFSC to provide the “best available” scientific data for fisheries management purposes would be compromised. This type of ecological information is also important to agencies and other institutions concerned about the health of the marine environment important to the protected species themselves. The NWFSC currently has no viable alternatives to collecting the data derived from these surveys that meet the research objectives described under the Purpose and Need (Chapter 1). As a result, NMFS does not propose to implement potential mitigation measures that would preclude continuation of these surveys, such as the elimination of night surveys or use of pelagic trawl gear.

The connected federal action covered under this DPEA is the issuance of regulations and subsequent LOAs for incidental takes of marine mammals under the MMPA, which requires NMFS to consider a

reasonable range of mitigation measures that may reduce the impact on marine mammals among other factors. As described above, some of these measures could prevent the NWFSC from maintaining the scientific integrity of its research programs. These measures would normally be excluded from consideration in the DPEA for not being consistent with the Purpose and Need. However, these additional mitigation measures would likely be considered during the MMPA rulemaking process and/or ESA section 7 consultation and are therefore analyzed in this DPEA.

Alternative 4 - No Research Alternative - No Fieldwork for Federal Fisheries and Ecosystem Research Conducted or Funded by NWFSC

Under the No Research Alternative, no direct impacts on the marine environment would occur from the primary or secondary federal actions. The NWFSC would no longer conduct or fund fieldwork for the fisheries and ecosystem research considered in the scope of this DPEA in marine waters of the Pacific Ocean, Puget Sound, and Lower Columbia River. This moratorium on fieldwork would not extend to research that is not in scope of this DPEA, such as directed research on marine mammals and ESA-listed species in other areas of the Pacific Northwest covered under separate research permits and NEPA documents. NMFS would need to rely on other data sources, such as fishery-dependent data (i.e., harvest data) and state or privately supported fishery-independent data collection surveys or programs to fulfill its responsibility to manage, conserve and protect living marine resources in the U.S. Under this alternative, organizations that have participated in cooperative research programs may or may not continue their research efforts depending on whether they are able to secure alternative sources of funding. Any non-federal fisheries research would occur without NMFS funding, direct control of program design, or operational oversight. It is unlikely that these non-NMFS fisheries research surveys would be compatible with the time-series data NMFS has collected over many years, which is the core information supporting NMFS science and management missions and vital to fishery management decisions made by NMFS, the Pacific Fishery Management Council and other marine resource management institutions, leading to greater uncertainty for fishery and other natural resource management decisions.

CHAPTER 3 – AFFECTED ENVIRONMENT

Chapter 3 presents baseline information on the marine environment affected by NWFSC research activities. This information is not intended to be encyclopedic but to provide a foundation for the analysis of environmental impacts of the alternatives and the cumulative effects analysis. Sources of additional information are incorporated by reference.

The marine environment affected by NWFSC research surveys includes the California Current Large Marine Ecosystem and adjacent deeper waters, marine waters of Puget Sound and associated estuaries up to the high tide influence, and the Lower Columbia River and associated estuarine waters up to the Bonneville Dam. There are many areas with special designations to protect various resources and are subject to various levels of conservation and management under a variety of authorities. Classifications of these special resource areas include Essential Fish Habitat, fisheries closure areas, and designated Marine Protected Areas including National Marine Sanctuaries.

There are thousands of finfish and shellfish species that occur within the NWFSC research areas. Descriptions or lists are provided for ESA-listed species/stocks, including listed Distinct Population Segments of several rockfish species, Pacific eulachon, and green sturgeon as well as numerous Evolutionarily Significant Units of six salmonid species. Species targeted by commercial fisheries and subject to NWFSC stock assessment research and other species caught frequently in NWFSC surveys are also described.

Marine mammal species that occur in the NWFSC research area are listed in Table 3.2-3, including 24 stocks of cetaceans (whales, dolphins, and porpoise), eight stocks of pinnipeds (seals and sea lions), and sea otters. All of these species are federally protected under the MMPA regardless of where they occur.

Six large whale species are listed as endangered under the ESA. Information is presented on marine mammal acoustics and functional hearing ranges for several groups of marine mammals. Marine mammals rely on sound production and reception for social interactions (e.g., reproduction and communication), to find food, to navigate, and to respond to predators.

Four ESA-listed bird species occur in the NWFSC research area. Five common species in these areas that have been caught in NWFSC research fishing gear are described. All species likely to occur in the U.S. EEZ are protected by the Migratory Bird Treaty Act.

Five species of sea turtles occur within the NWFSC research area, all of which are listed as endangered or threatened under the ESA. Sea turtles are susceptible to damage of onshore nesting habitat, exploitation of eggs, and interactions with research, sport, and commercial fisheries.

There are two ESA-listed invertebrates in the NWFSC research area, black and white abalone. The NWFSC conducts research and provides stock abundance and distribution information for management of several commercially valuable invertebrates, including market squid and ocean pink shrimp. Other invertebrates that are frequently caught in NWFSC research surveys are listed.

Several components of the social and economic environment are summarized. A number of commercial fisheries harvest marine fish and invertebrates in West Coast waters. Complex associations exist between the fishing industry, fisheries management processes, and the social well-being of many communities. Recreational and Native American tribal fisheries also play an important role in the well-being of individuals and communities. These fisheries and communities receive scientific and economic benefits from the NWFSC research activities as they contribute to the scientific management of sustainable fisheries. In addition, NWFSC fisheries research is an important component of the U.S. federal government's trust responsibility to Native American tribes through a co-management relationship relative to living marine resources and habitats. Tribes are potentially affected by the NWFSC fisheries research and a brief description of tribal fishing rights is described. Information is also presented on the basic operating costs of the NWFSC (approximately \$42 million annually) and average costs for conducting NWFSC research programs. These expenses include funds for ship time, fuel and supplies, crew, charter vessels, and other logistic support, which directly and indirectly benefits communities on the U.S. West Coast.

CHAPTER 4 – ENVIRONMENTAL EFFECTS

As indicated earlier, NMFS is fundamentally a science-based agency, with its primary mission being the stewardship of living marine resources through science-based conservation and management. Of the four alternatives evaluated in this DPEA, three alternatives maintain an active research program (Status Quo, Preferred, and Modified Research Alternatives) that clearly enables collection and development of additional scientific information, and one alternative (No Research) does not. In NMFS view, the inability to acquire scientific information essential to developing robust fisheries management measures that prevent overfishing and rebuild overfished stocks would ultimately imperil the agency's ability to meet its mandate to promote healthy fish stocks and restore the nation's fishery resources. The scientific information provided by fisheries research programs also allows NMFS to address potential effects of climate change and ocean acidification. Long-term, consistent fisheries and ecosystem research programs contribute substantially to developing effective and timely fisheries management actions and assists in meeting U.S. trust responsibilities and international treaty obligations.

The following discussion summarizes the direct and indirect impacts by resource area associated with the alternatives evaluated in Chapter 4 of this DPEA. The effects of the alternatives on each resource category were assessed using an impact assessment criteria table to distinguish between major, moderate, and minor effects within the context of each resource category. The analysis shows that the potential direct and indirect impacts on the physical and biological environments under the three research alternatives are similar and would have minor adverse effects. The three research alternatives would also

have minor to moderate beneficial effects on the social and economic environment of fishing communities by providing the scientific information needed for sustainable fisheries management and by providing funding, employment, and services. The similarity of impacts among the three research alternatives is due to the fact that the scope of research activities under these alternatives is similar; they differ primarily in the type of mitigation measures included for protected species. The No Research Alternative, in contrast, would eliminate the direct adverse effects of the research alternatives on the marine environment but would have minor to moderate adverse, indirect effects on several biological resources due to increasing uncertainty in future resource management decisions caused by the loss of scientific information on the marine environment from the NWFSC. The No Research Alternative was also considered to have minor to moderate adverse effects on the social and economic environment of fishing communities by having relatively minor to moderate economic impacts on various communities as well as long-term and widespread adverse impacts on sustainable fisheries management. Table ES-1 provides a summary of impact determinations for each resource by alternative.

Table ES-1 Summary of Environmental Effect Conclusions for Each Alternative

Topic	Alternative 1 (Status Quo)	Alternative 2 (Preferred)	Alternative 3 (Modified Research)	Alternative 4 (No Research)
Physical Environment	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor <i>adverse</i>
Special Resource Areas	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor <i>adverse</i>
Fish	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor to moderate <i>adverse</i>
Marine Mammals	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor <i>adverse</i>
Birds	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor <i>adverse</i>
Sea Turtles	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor <i>adverse</i>
Invertebrates	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor to moderate <i>adverse</i>
Social and Economic Environment	Minor to moderate <i>beneficial</i>	Minor to moderate <i>beneficial</i>	Minor to moderate <i>beneficial</i>	Minor to moderate <i>adverse</i>

Physical Environment and Special Resource Areas

Under the three research alternatives, direct impacts to benthic habitats would occur through the use of several bottom-contact fishing gears (primarily bottom trawl gear). The DPEA includes an analysis of the total footprint of NWFSC-affiliated research on benthic habitat, including EFH, the effects of which are considered small in magnitude, short-term in duration, and localized in geographic scope. An analysis is presented on the proportion of research sampling and biomass removals made within five National Marine Sanctuaries in the Pacific. The numbers of samples taken within each of the sanctuaries and the removals of fish and invertebrates for scientific purposes are relatively small and would have temporary and minor adverse effects.

Under the No Research Alternative, there would be no direct impacts on the physical environment or special resource areas from federal fisheries and ecological research. However, the loss of scientific information generated by NWFSC research would contribute to greater uncertainty about the effects of

climate change and ocean acidification on Pacific marine ecosystems as well as the status of biological resources in marine protected areas. Indirect effects on resource management agencies and conservation plans for protected areas would likely be adverse and minor in magnitude under the No Research Alternative.

Fish

The NWFSC conducts and funds stock assessment and habitat research for many commercially valuable and culturally important fish species, providing the scientific basis for sustainable fisheries management. NWFSC research also provides critical information on oceanographic conditions and the status of other fish species that are not harvested but which play key roles in the marine food web, providing the scientific basis for NMFS goal of ecosystem-based management, as outlined in NOAA Fisheries Strategic Plan (NOAA 1997). Under the three research alternatives, relatively small impacts to fish populations are expected as a result of on-going research activities; for species managed by NMFS under the MSA, these impacts are already considered as part of the fishery specifications processes. Mortality from captures in surveys is a potential impact for some ESA-listed non-salmonid species (Distinct Population Segments (DPS) of Puget Sound/Georgia Basin canary rockfish and Southern DPS of Pacific eulachon) but estimated levels of catch in NWFSC fisheries research activities are small and considered minor to their respective populations. ESA-listed salmonid species caught during NWFSC research surveys include Puget Sound/Coastal DPS bull trout, numerous ESUs of chinook salmon, Columbia River and Hood Canal summer-run chum salmon, several ESUs of Coho salmon, Ozette Lake and Snake River sockeye salmon, and numerous DPS of steelhead. However, almost all of the ESA-listed salmonids caught in all research areas are small juveniles and most of these fish are returned to the water after careful processing. The overall adverse effects to ESA-listed species are therefore considered minor. In contrast, NWFSC fisheries research also provides substantial beneficial effects for ESA-listed species by contributing scientific data on population structures, movement patterns, and responses to habitat alterations such as coastal development and the removal of the Elwha Dam.

For most species targeted by commercial fisheries and other anglers, mortality due to research surveys and projects is much less than one percent of commercial harvest and is considered to have minor adverse effects for all species. For a few species which do not have a large commercial market due to various market conditions or past overfishing, the research catch exceeds one percent of commercial catch but is still small relative to the population of each species and is considered minor. NMFS Policy Directive 01-108, October 28, 2008, requires Scientific Research Permits for agency-conducted and/or funded research that will affect species regulated under the MSA. Those proposed research projects that will affect MSA species are reviewed annually before research permits are issued to determine if they are consistent with existing analyses and fishery management goals and objectives and to ensure compliance with the agency's National Standard guidelines under the MSA that require that all sources of mortality be accounted for in the management of each species. See 50 C.F.R. § 600.310(e)(3)(v)(C).

For species that are not managed under FMPs, research catch is also relatively small and considered to be minor for all species. Mortality for all species would be distributed across a wide geographic area rather than concentrated in particular localities. In contrast to these adverse effects on fish, NWFSC research also provides long-term beneficial effects on target species populations through its contribution to sustainable fisheries management. Data from NWFSC-affiliated research provides the scientific basis to reduce bycatch, establish optimal fishing levels, prevent overfishing, and recover overfished stocks.

Under the No Research Alternative, there would be no direct adverse impacts on fish from NWFSC fisheries research. However, the loss of scientific information for fisheries management could have long-term minor to moderate adverse impacts on fish stocks through increasing uncertainty in fisheries management decisions, which could lead to potential overfishing on some stocks, uncertainty about the recovery of overfished stocks, and increasing uncertainty about the efficacy of fishing regulations designed to protect fish stocks and habitat from overfishing.

Marine Mammals

The primary direct effects of the three research alternatives on ESA-listed and non-listed marine mammals include behavioral responses to sound produced through the use of active acoustic sources and the physical presence of researchers (Level B harassment under the MMPA), incidental capture or entanglement in fishing gear but released without serious injury (Level A harassment), and incidental capture or entanglement resulting in serious injury or mortality. These all constitute takes of marine mammals under the MMPA. The potential for effects from ship strikes, contamination of the marine environment, and removal of marine mammal prey species was considered minor for all alternatives and species. The MMPA requires applicants for regulations and subsequent LOAs to estimate the number of each species of marine mammal that may be incidentally taken by Level A and Level B harassment or serious injury/mortality during the proposed action. The NWFSC LOA application (attached to the DPEA as Appendix C) includes estimates of marine mammal takes in the three NWFSC research areas using the scope of research and mitigation measures described in the Preferred Alternative.

The LOA application combines estimated Level A harassment takes with serious injury or mortality takes because the degree of injury resulting from gear interaction cannot be predicted. The estimated take numbers are based on the historical capture of 26 non-ESA-listed cetaceans (24 Pacific white-sided dolphins and two undetermined dolphins or porpoises) and 16 pinnipeds (four California sea lions, eight eastern DPS Steller sea lions (which were ESA-listed as threatened at the time of capture but have recently been de-listed), one northern fur seal, and three harbor seals) during NWFSC research surveys from 1999 through 2014. Past marine mammal captures have all occurred using surface trawls. Of the 42 animals captured, only one California sea lion and one harbor seal were released alive.

For the species that have been taken by entanglement in research gear in the past, the LOA application uses a conservative approach for estimating future takes, using the average annual number of animals caught in different gear types in the past 15 years (1999-2014), rounding up to the nearest whole number of animals, and assuming this number of animals could be caught every year for the next five years (MMPA regulations concerning incidental take of marine mammals, if promulgated, and subsequent Letters of Authorization, would likely be issued for a five-year period). The NWFSC considers this estimation method to be conservative in that it likely overestimates the number of animals that could be caught in the future in order to ensure accounting for a precautionary amount of potential take. The DPEA uses the estimated takes in the LOA application to assess the impacts on marine mammals. Given the likelihood that these are overestimates, the actual effects from injury, serious injury or mortality could be substantially less than described.

Other species that have not been captured in the past have been included in the LOA application's request for take authorization based on their similarity to species that have been taken by the NWFSC and incidental take in analogous commercial fisheries. Because the scope of research activities under the Status Quo Alternative is very similar to the Preferred Alternative, the estimated take numbers from the LOA application are used as part of the analysis of effects on marine mammals in this research area under both alternatives. However, the Preferred Alternative includes several gear modifications, including incorporation of marine mammal excluder devices on Nordic 264 surface trawls, and expanded protected species training requirements that should reduce the potential of adverse gear interactions with marine mammals relative to the Status Quo Alternative.

The DPEA includes a summary table with the number of estimated Level A harassment/serious injury or mortality takes for each species affected in each of the three NWFSC research areas. One of the key elements of the effects analysis is to determine the adverse impact of takes on each species. The DPEA and LOA application compare estimated future takes for each species with its Potential Biological Removal (PBR) as part of this impact determination. The MMPA defines PBR as, "...the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population." PBR was intended to

serve as an upper limit guideline for fishery-related mortality for each species. Given the similarity of fisheries research to many commercial fisheries and the role research plays in supporting commercial fisheries, it is appropriate to assess the impacts of incidental takes for fisheries research in a similar manner.

PBR is used as one of the criteria for determining the level of adverse impacts on marine mammals in the DPEA (see Section 4.1.2). For the purposes of this analysis under NEPA, research-related incidental serious injury or mortality less than or equal to 10 percent of PBR for the marine mammal stock is considered minor in magnitude for the population. Serious injury or mortality between 10 percent and 50 percent of PBR is considered moderate in magnitude. Serious injury or mortality greater than or equal to 50 percent of PBR is considered major in magnitude.

For almost all stocks of marine mammals (except bottlenose dolphins) considered to have potential for interactions with NWFSC fisheries research, the average annual requested number of Level A harassment/serious injury and mortality takes in all gear types and all research areas combined is well below 10 percent of PBR for all species, even if all annual takes were from a single stock for species with multiple stocks. These takes, if they occurred, would likely be rare or infrequent events, would be distributed over large geographic areas, and would be considered to have overall minor adverse effects on the population of each species. The NWFSC take request also includes “undetermined dolphin or porpoise” and “undetermined pinniped” takes to account for similar-looking animals that may escape from the net or hook-and-line gear before being brought on board or identified. However, for impact analysis purposes, we must assign these undetermined takes to each stock in addition to those takes requested for the particular stock. Under these assumptions the combined take request would still be well below 10 percent of PBR for most stocks and would be considered minor in magnitude. The potential exceptions are for stocks with very small or unknown PBR values, i.e. one coastal and one offshore stock of bottlenose dolphin, where these added takes could be moderate in magnitude relative to PBR. However, the assumptions of this worst case scenario are highly unlikely to occur given the lack of historical takes for this species, let alone these particular stocks. The chances of all future “undetermined” delphinids actually coming from any one stock are so remote as to be discountable. In addition, the small population sizes of these stocks, the limited scope of NWFSC research efforts within their ranges, and the mitigation measures in place to avoid marine mammal interactions (see Section 2.2.2) further reduce the risk of gear interactions with these stocks. The NWFSC therefore considers the potential effects of NWFSC research on all marine mammal stocks to be minor.

Level B harassment takes are estimated based on the acoustic properties of sonars and other acoustic equipment used during research, calculations of the volume of water insonified to 160 decibels root mean square referenced to 1 micropascal at one meter or more (NMFS current recommended threshold for Level B harassment from the active acoustic equipment considered in this DPEA), estimates of the densities of marine mammals in different areas, and a partitioning of species that typically do not dive deeper than 200 meters and those that do (which affects the size of the insonified area to which they may be exposed). The DPEA includes a summary table of the number of estimated Level B harassment takes by acoustic sources of each species affected in the California Current research area. Active acoustic equipment of the kinds that could cause Level B harassment is not used during NWFSC research in Puget Sound or the Lower Columbia River. The DPEA also includes a summary of an assessment of biological effects from NWFSC acoustic equipment used during research (Appendix C, Section 7). Output frequencies of some active acoustic sources (i.e., short range echosounders and Acoustic Doppler Current Profilers) are higher than the functional hearing ranges of marine mammals so no adverse effects are anticipated. Other acoustic sources operate at frequencies within the hearing range of one or more groups of marine mammals and may cause temporary and minor behavioral reactions such as swimming away from an approaching ship. None of the NWFSC acoustic equipment is likely to present risks of hearing loss or injury to any marine mammal.

Level B harassment takes also may occur to several species of pinnipeds due to the physical presence and passage of researchers within Puget Sound and the Lower Columbia River. NWFSC researchers are very aware of this situation and take precautions to minimize the frequency and scope of potential disturbances, including choosing travel routes as far away from hauled out pinnipeds as possible and moving sample site locations to avoid consistent haulout areas. However, there are many narrow channels among the islands of Puget Sound where the options for vessel traffic are limited. Combined with the fact that pinnipeds may haul out in new locations on a regular basis, it is essentially impossible for researchers to completely avoid disturbing pinnipeds as they move throughout the region.

Visual and acoustic deterrence devices and techniques are occasionally used to deter pinnipeds attempting to enter or remove fish from research gear during the Pair Trawl Columbia River Juvenile Salmon Survey and the Migratory Behavior of Adult Salmon Survey in the Lower Columbia River. These animals are considered “nuisance animals” and non-lethal deterrence by government employees is exempted under Section 109(h)(1)(C) of the MMPA. Methods used by NWFSC fisheries scientists to deter pinnipeds include close approach to animals in skiffs, aerial pyrotechnics (poppers and screamers), and, as a last resort, underwater detonation of seal bombs.

The Modified Research Alternative includes the same scope of research in the NWFSC research areas as the Preferred Alternative but considers a number of other potential mitigation measures that the NWFSC is not proposing to implement in its LOA application. These include a number of alternative methods for monitoring for protected species (e.g., use of dedicated Protected Species Observers and passive acoustic devices), gear modifications such as marine mammal excluder devices for all trawl gear, and spatial/temporal restrictions on where and when research can occur. The NWFSC considers the suite of mitigation measures to be implemented under the Preferred Alternative to represent the most effective and practicable means to reduce the risk of adverse interactions with marine mammals during the conduct of its research program without compromising the scientific integrity of the research program. The potential direct and indirect effects of this alternative on marine mammals would be the same as described for the Preferred Alternative except for the potential of the additional mitigation measures to reduce Level A harassment/serious injury and mortality takes through gear interactions.

Scientists at the NWFSC regularly review their procedures to see if they can do their work more efficiently and with fewer incidental effects on the marine environment, including effects on marine mammals. However, any changes to operational procedures or the equipment used during surveys must also be considered from the standpoint of how they affect the integrity of the scientific data collected, the cost of implementing equipment or operational changes, and the safety of the vessel and crew. It would be speculative to quantify how much any one of these measures (or some combination of them) may reduce the risk of future takes relative to the Status Quo or Preferred Alternatives. The analysis of the Modified Research Alternative provides a qualitative discussion of the potential for each additional mitigation measure to reduce takes and other effects on marine mammals as well as how each measure may affect practicability, time-series data integrity, and other aspects of the research survey work. One element of the Modified Research Alternative (e.g., use of Protected Species Observers) would offer mitigation advantages compared to the Status Quo Alternative but is addressed to some extent in the Preferred Alternative. Operational restrictions such as not allowing trawls to be set at night or in poor visibility conditions and spatial/temporal restrictions to avoid high densities of marine mammals would certainly reduce the risk of taking marine mammals. However, such restrictions would have a serious adverse impact on the ability of the NWFSC to collect certain kinds of research data and would have impacts to the cost and scope of research that could be conducted. Some concepts and technologies considered in the Modified Research Alternative are promising as a means to reduce risks to marine mammals and NMFS will evaluate the potential for implementation if they become more practicable.

Under the No Research Alternative, no direct adverse impacts to marine mammals from fisheries and ecological research (i.e., takes by gear interaction and acoustic disturbance) would occur. However, many of the NWFSC research projects that would be eliminated under this alternative contribute valuable

ecological information important for marine mammal management, especially for ESA-listed species and species considered depleted under the MMPA. The loss of information on marine mammal habitats would indirectly affect resource management decisions concerning the conservation of marine mammals, especially as time went on and uncertainty about the status of the marine environment increased. There are too many unknown variables to estimate the specific effects this lack of information would mean to any particular stock of marine mammals but the No Research Alternative would likely have minor to moderate adverse effects for some species.

Birds

The effects of NWFSC fisheries research on seabirds include the potential for injury and mortality in fishing gear and ship strikes, changes in food availability, and contamination or degradation of habitat. All three of the research alternatives include the use of fishing gear (i.e., trawls, seines, and hook-and-line gear) that have had substantial incidental catch of seabirds in commercial fisheries of the Pacific. However, research gear is generally smaller than commercial gear and research protocols are quite different than commercial fishing practices. In particular, fisheries research uses much shorter duration trawls/sets than commercial fisheries and no bait/offal is thrown overboard while research gear is in the water, thereby greatly reducing the attraction of seabirds to research vessels. From 2002 through 2014 a total of 20 seabirds of five species have been killed during NWFSC research activities, all during the Juvenile Salmon PNW Coastal Survey using a Nordic 264 surface trawl. The takes consisted of 14 common murrelets, two tufted puffins, two rhinoceros auklets, and one each of Cassin's auklet and sooty shearwater. The magnitude of these incidental takes are considered minor for the populations of all species.

Under the Modified Research Alternative, the NWFSC would deploy streamer lines before longline gear is set to mitigate the risk of catching seabirds. If seabird interactions with research longline gear are documented in the future, the NWFSC will revisit whether use of streamer lines is warranted given the tradeoffs between the potential conservation benefit and operational and safety considerations.

Some NWFSC surveys take bird biologists on board when there is bunk space available to conduct transect surveys for bird distribution and abundance in the NWFSC research area. This information is used by NMFS, the U.S. Fish and Wildlife Service, and other international resource management agencies to help with bird conservation issues and is considered to have indirect beneficial effects on the birds.

Under the No Research Alternative, the risk of direct adverse effects on seabirds from NWFSC research would be eliminated, but there could be potential long-term minor adverse impacts to seabirds because resource management authorities would lose ecological information about the marine environment important to seabird conservation.

Sea Turtles

The DPEA analyzes the same direct and indirect effects of NWFSC fisheries research on sea turtles as described for marine mammals. The potential for ship strikes, removal of prey, and contamination of marine habitat would be similar to the risks described for marine mammals; these effects are considered minor adverse for all species under all three research alternatives. Sea turtles hearing range is apparently well below the frequencies of acoustic instruments used in fisheries research so turtles are unlikely to detect these sounds or be affected by them. The NWFSC has no history of interactions with sea turtles in research gear and the potential for injury or mortality under all of the research alternatives is very small. The overall effects of the research alternatives on ESA-listed sea turtles would be minor adverse.

As with seabirds and marine mammals, the No Research Alternative would eliminate the risk of direct adverse effects on sea turtles from NWFSC research. However, there could be minor adverse impacts due to the loss of ecological information important to sea turtle conservation.

Invertebrates

The NWFSC conducts stock assessment and habitat research for several important invertebrate species (i.e., ocean pink shrimp and market squid) and, similar to the situation described for commercially valuable fish species, the magnitude of mortality due to research sampling is small relative to commercial harvests. The footprint of bottom trawl gear used in research is also relatively small and impacts to benthic infauna and epifauna would be temporary. The NWFSC conducts research in several areas closed to commercial fishing but much of this research is the primary means for NMFS to monitor the recovery of benthic habitat and the efficacy of fisheries conservation measures. Under the three research alternatives, minor adverse impacts to invertebrates are expected from NWFSC research activities. NWFSC research is important for the scientific and sustainable management of these valuable fisheries, helping to prevent overfishing on the stocks.

Under the No Research Alternative, direct adverse impacts to invertebrates would be eliminated. However, the loss of stock assessment and marine environment information could indirectly result in minor adverse effects on commercially targeted species through increasing uncertainty in the fishery management environment.

Social and Economic Environment

Under the three research alternatives, long term, beneficial impacts to the social and economic environment are expected from ongoing NWFSC fisheries and ecosystem research activities. NWFSC research provides important scientific information which is the basis for sustainable fisheries management for some of the most valuable commercial and culturally important fisheries along the U.S. West Coast, which benefits communities that support them. These commercial and recreational fishing industries have large economic footprints, generating billions of dollars' worth of sales and thousands of commercial fishing-related jobs, and provide millions of people across the country with highly valued seafood. The importance of some of the salmon fisheries and other fisheries to Pacific Northwest tribes goes beyond monetary or nutritional value and is essential to their cultural identity. Millions of recreational fishers also participate and support fishing service industries. NWFSC fisheries research activities would also have minor to moderate beneficial impacts to the economies of fishing communities through direct employment, purchase of fuel, vessel charters, and supplies. Continued NWFSC fisheries research is important to build trust and cooperation between the fishing industry and NMFS scientists and fisheries managers. It is also essential for fulfilling the trust responsibilities with tribal co-managers of living marine resources.

The No Research Alternative would likely have minor to moderate adverse impacts on the social and economic environment through greater uncertainty in fisheries management, which could lead to more conservative fishing quotas (i.e., underutilized stocks and lost opportunity) or an increased risk of overfishing, followed by reductions in commercial and recreational fisheries harvests. The lack of scientific information would also compromise efforts to rebuild overfished stocks and monitor the effectiveness of no-fishing conservation areas. These impacts would adversely affect the ability of NMFS to comply with its responsibilities under the MSA. It would also eliminate research-associated federal spending on charter vessels, fuel, supplies, and support services in various communities. The No Research Alternative would also have long-term adverse impacts on the scientific information the NWFSC contributes to meet U.S. obligations for living marine resource management under international treaties and tribal co-management agreements.

CHAPTER 5 – CUMULATIVE EFFECTS

Cumulative effects are the impacts on the environment which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions on the human environment over time. An individual action may have only minor or moderate impacts, but the

cumulative effects of all actions may be major. NEPA requires an analysis of cumulative effects in order to alert decision makers to the full environmental consequences of a proposed action and its alternatives on resource areas of concern. This analysis looks at the overall cumulative impact and the contribution of fisheries research activities to the overall cumulative impact.

In terms of fisheries, understanding how the cumulative impacts from human activities and trends in the natural environment have influenced the marine environment over time is key to understanding the importance of NMFS role in fisheries management. The need for scientific information from NWFSC research activities is in large part the result of past actions that contributed to major adverse impacts on fish stocks from overfishing, pollution of coastal and ocean areas from accidental and intentional discharges, runoff of agricultural and industrial waste, and degradation of habitat from commercial fishing and dam construction, among other activities. Federal efforts within the last 40 years to reduce pollution, restore degraded habitats, and effectively manage commercial and recreational fishery harvests have reversed some of these trends. A number of important fishery stocks have been restored to healthy levels and others are in the rebuilding process.

Similarly, cumulative impacts from human activities and trends in the natural environment over time have contributed major adverse impacts to populations of marine mammals, sea turtles, and other marine species. As a result, the MMPA and ESA were enacted to help address specific conservation concerns and many human activities are subject to federal management measures to protect marine species and promote recovery of impacted populations.

Climate change and increase in ocean acidification have the potential to impact populations and distributions of many marine species. Fisheries research activities make a minimal contribution to these long-term, global environmental processes through the burning of fossil fuels. However, long-term, systematic marine research provides important scientific information on the changes and trends in marine ecosystems brought about by climatic and oceanic forces.

In addition to NWFSC research efforts, there are many current and reasonably foreseeable activities that may contribute to cumulative impacts on the marine environment, including: conservation efforts, commercial shipping, commercial and recreational fisheries, oil and gas and alternative energy development, military activities, coastal development projects, marine research activities by other agencies and institutions, and other human activities that contribute to global climate change. These actions can produce both adverse and beneficial impacts that directly and indirectly affect ocean resources managed by NMFS and the social and economic environment of fishing communities that rely on them.

This DPEA generally considers the contribution of the three research alternatives to the cumulative effects on given resources to be very similar and they are often discussed together. The contribution of the No Research Alternative to the cumulative effects on resources is quite different and is discussed separately.

As described in the Chapter 4 summary above, NWFSC research activities would have minor adverse effects on the various resource components of the physical and biological environments. Because NWFSC research activities involve such a small number of vessels compared to other vessel traffic and collect relatively small amounts of biomass compared to commercial and recreational fisheries, the contribution of the three research alternatives to cumulative adverse effects on fish, marine mammal, and other species and resource areas would be small under normal conditions. NWFSC scientific research activities will also have beneficial contributions to the cumulative effects on both biological and socioeconomic resources. The research alternatives contribute substantially to the science that feeds into federal fishery management measures aimed at rebuilding and managing fish stocks in a sustainable manner. It also contributes to understanding the nature of changes in the marine environment and adjusting resource management plans accordingly, and it helps meet co-management and international treaty research obligations. The research activities under the three research alternatives help alleviate

adverse cumulative impacts on the biological and socioeconomic environments, resulting in long-term beneficial contributions to cumulative effects.

The No Research Alternative would not contribute to direct adverse effects on the marine environment (e.g., research catch of fish and incidental take of marine mammals) but would contribute indirect adverse effects on both the biological and socioeconomic environments based on the lack of scientific information to inform future resource management decisions.

OTHER SECTIONS

In addition to the chapters summarized above, the DPEA includes a description of the laws applicable to NWFSC research activities in Chapter 6, cited references in Chapter 7, and a list of persons and agencies consulted in Chapter 8. Appendix A provides a description of the fishing gear, other scientific instruments, and vessels used during NWFSC research activities. Appendix B includes tables and figures showing the seasonal distribution of research effort in the NWFSC research area. Appendix C is the NWFSC's application for promulgating regulations and issuing LOAs for incidental take of marine mammals under the MMPA from NMFS OPR. Appendix D contains proposed handling and data collection procedures for marine mammals, sea turtles, and other protected species that are incidentally caught in NWFSC fisheries research activities; these procedures would be implemented after the NWFSC receives authorization for such incidental takes when the MMPA LOA and ESA consultation processes are completed.

CONCLUSION

Based on the analysis in this DPEA, NMFS has not identified any potential adverse environmental impacts that would rise to the level of "significant" under NEPA, thus triggering the requirement for an EIS. NMFS will not make a final determination about significance until the close of the 30-day public comment period on the draft DPEA and it has received all the public comments. A final determination on whether potential impacts of the proposed action are significant will be made with consideration of public comments and will be published in the Federal Register.

1.1 NOAA'S RESOURCE RESPONSIBILITIES AND ROLE IN FISHERIES RESEARCH

The federal government has a responsibility to protect living marine resources in waters of the United States (U.S.), also referred to as federal waters. These waters generally lay 3 to 200 nautical miles from the shoreline, and comprise the Exclusive Economic Zone (EEZ). To carry out its responsibilities over federal and international waters, Congress has enacted several statutes authorizing certain federal agencies to administer programs to manage and protect living marine resources. Among these federal agencies, the National Oceanic and Atmospheric Administration (NOAA) has the primary responsibility for protecting marine finfish and shellfish species and their habitats. Within NOAA, the National Marine Fisheries Service (NMFS) has been delegated primary responsibility for the science-based management, conservation, and protection of living marine resources within the U.S. EEZ.

Within the area covered by this Draft Programmatic Environmental Assessment (DPEA), NMFS manages marine organisms, habitat, and ecosystems under the provisions of several major statutes, including the Magnuson-Stevens Fishery Conservation and Management Act (MSA)⁵, the Marine Mammal Protection Act (MMPA), the Endangered Species Act (ESA), the Pacific Salmon Treaty Act, and two treaties with Native American tribes inside the EEZ off the Washington Coast. Accomplishing the requirements of these statutes requires a complex fishery management process involving the close interaction of several entities. In the NMFS West Coast Region, the entities involved are the Northwest Fisheries Science Center, Southwest Fisheries Science Center, NMFS West Coast Region, NMFS Headquarters, the Pacific Fishery Management Council, the Pacific Salmon Commission, the Pacific States Marine Fisheries Commission, Native American tribal governments, state agencies, stakeholder groups, and several International fisheries management organizations.

1.1.1 Fisheries Science Centers

Six Regional Fisheries Science Centers⁶ direct and coordinate the collection of scientific information on living marine resources and their ecosystems to assist resource managers in making sound decisions that build sustainable fisheries, facilitate the protection and recovery of threatened and endangered species, and sustain healthy ecosystems. Each Fisheries Science Center is a distinct entity and provides the primary scientific support for a particular NMFS fisheries region (Figure 1.1-1). Until recently, the Northwest Fisheries Science Center (NWFSC) provided scientific support for NMFS Northwest Region while the Southwest Fisheries Science Center (SWFSC) provided scientific support for NMFS Southwest Region. In the fall of 2013, NMFS merged the Northwest and Southwest regional offices into a single administrative unit, the West Coast Region. However, the NWFSC and SWFSC remain separate research institutions which independently contribute scientific information to the West Coast Region, although they frequently collaborate and have overlapping geographical research areas.

The NWFSC conducts research primarily in U.S. marine waters from Canada to Mexico, including estuaries and freshwater systems of Puget Sound and the major rivers in Washington and Oregon, but occasionally conducts fisheries research in marine waters as far north as Southeast Alaska. The NWFSC is based out of the Montlake Laboratory and Headquarters in Seattle, Washington and also includes five research stations: Mukilteo, Manchester, Point Adams, Pasco, and Newport (Figure 1.1-2). The unique assets of each of these facilities enable NWFSC scientists to pursue various areas in fisheries research to support the agency's mission. This DPEA assesses the impacts of research activities conducted by the NWFSC in three geographic areas that roughly correspond to: 1) the California Current area of the Pacific

⁵ 16 U.S.C. §§ 1801-1884, (MSA 2007).

⁶ These Science Centers are: 1) Northeast, 2) Southeast, 3) Southwest, 4) Northwest, 5) Alaska, and 6) Pacific Islands.

Ocean (Figure 1.1-2); 2) Puget Sound and associated estuaries up to high tide line (Figure 1.1-3); and 3) the lower Columbia River below the Bonneville Dam and associated estuaries up to high tide line (Figure 1.1-4). The geographic scope of NFWSC's research extends into the freshwater streams and lakes of Washington, Oregon, Montana, and Idaho but this DPEA does not cover research activities in those freshwater areas.

The NFWSC main campus is located close to the University of Washington at the Montlake Facility in Seattle and has been a focal point of marine science since 1931. The facility includes the office of the Science Director, the directorates for each of the five science divisions, and much of the NFWSC laboratory space. It also features an innovative freshwater recirculation system, special aquaculture and biotoxin research facilities and an extensive marine science research library.

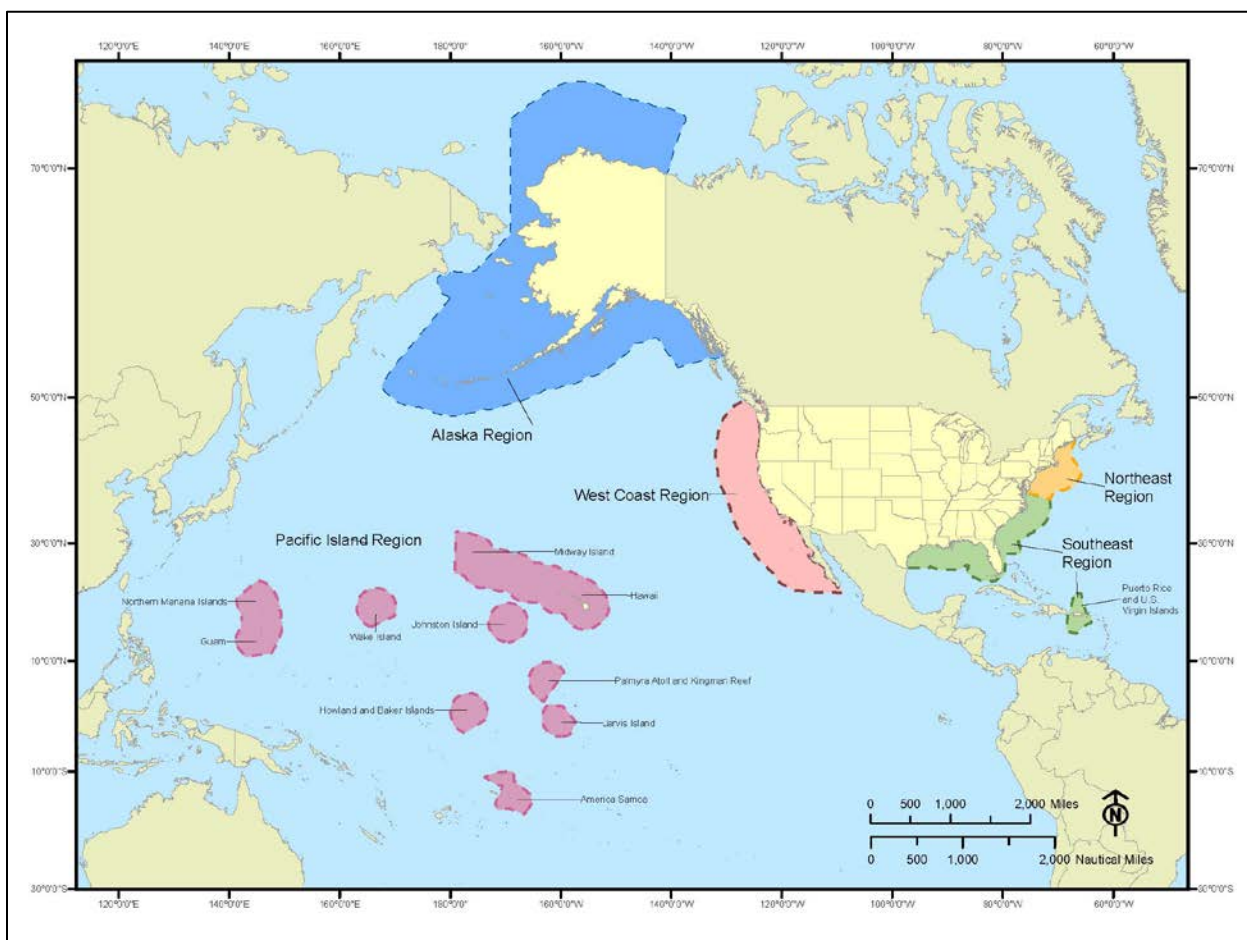


Figure 1.1-1 NMFS Fisheries Regions

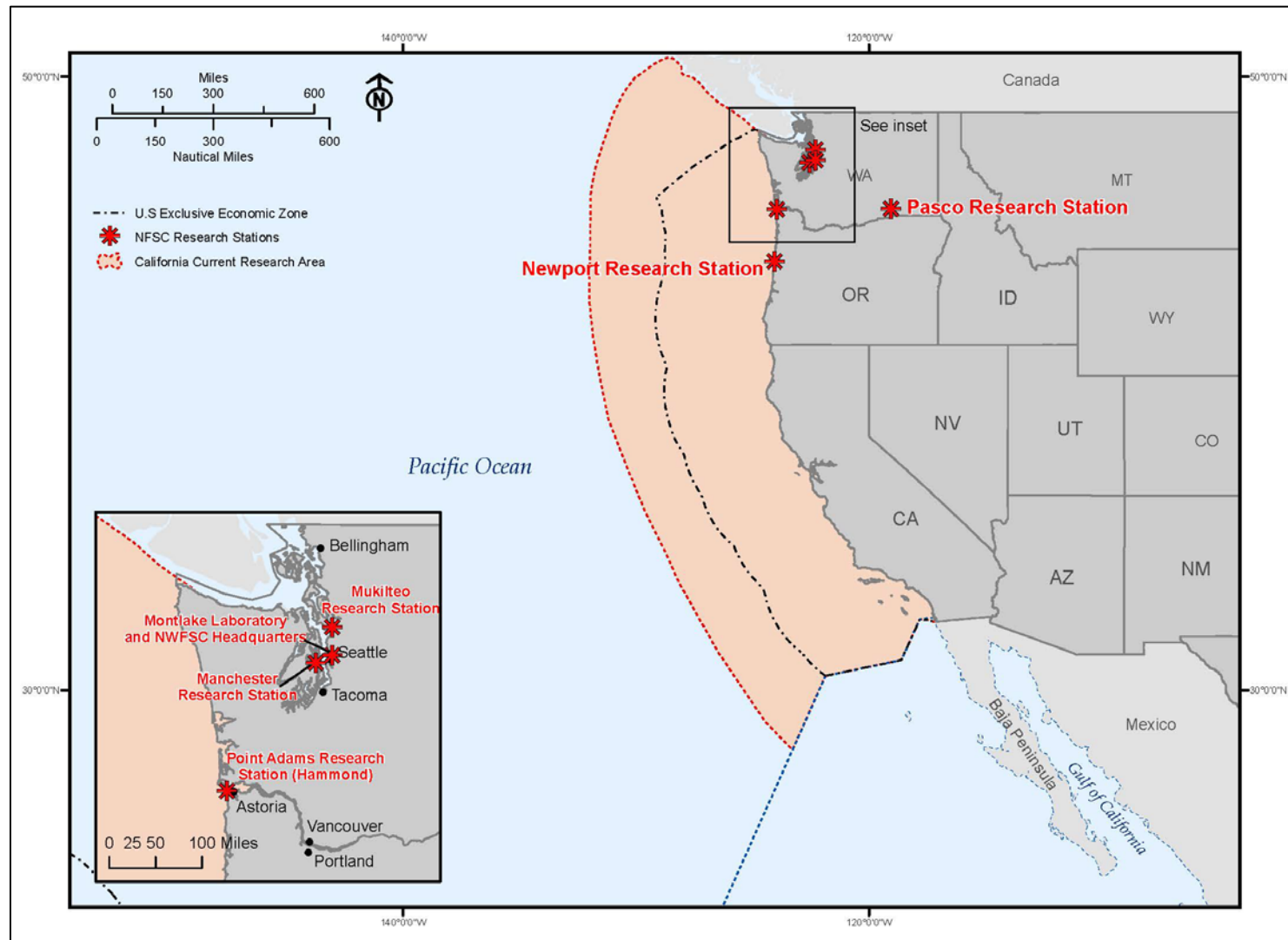


Figure 1.1-2 Locations of NWFSC Research Facilities and the California Current Research Area

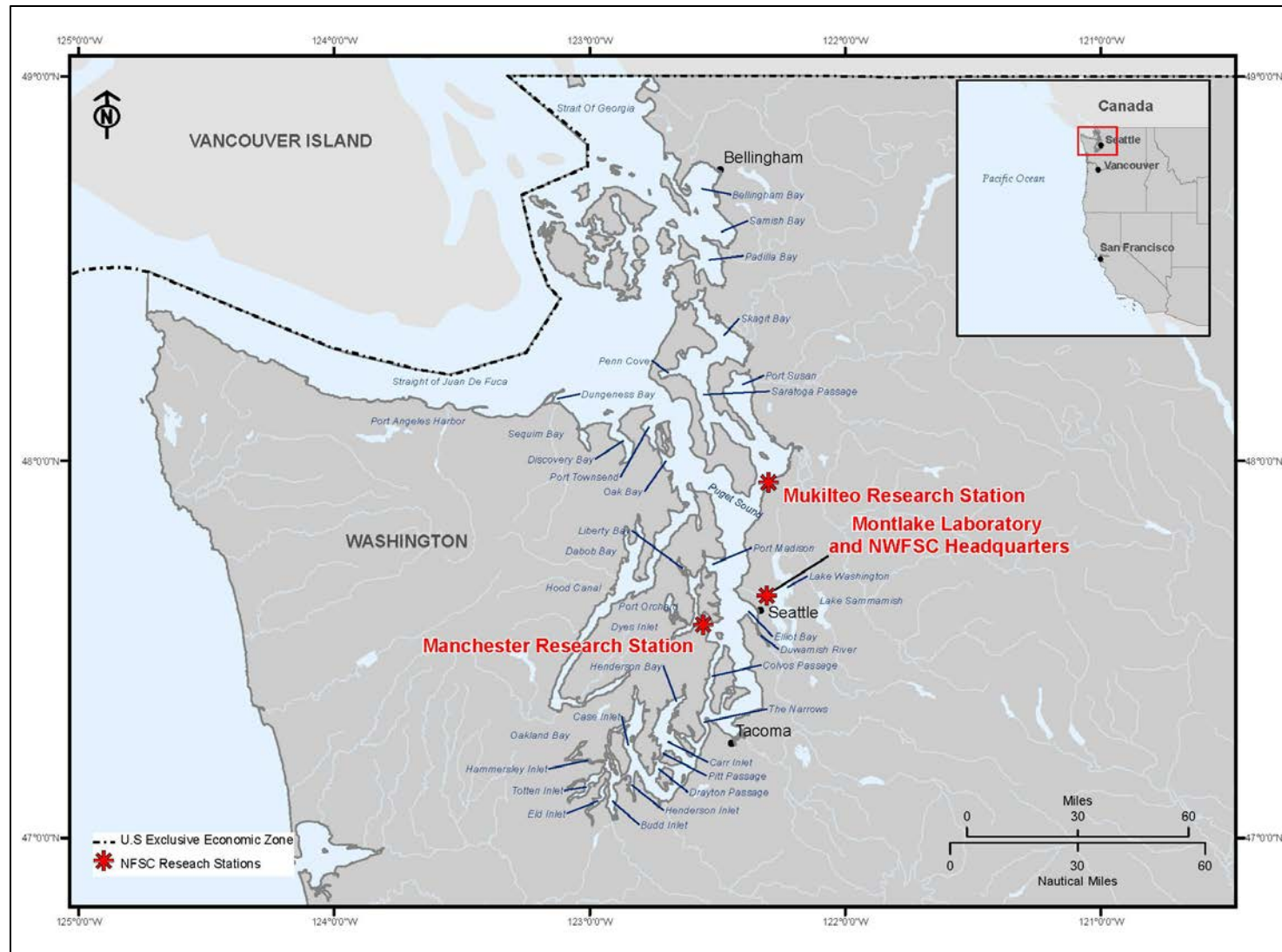


Figure 1.1-3 Puget Sound Research Area

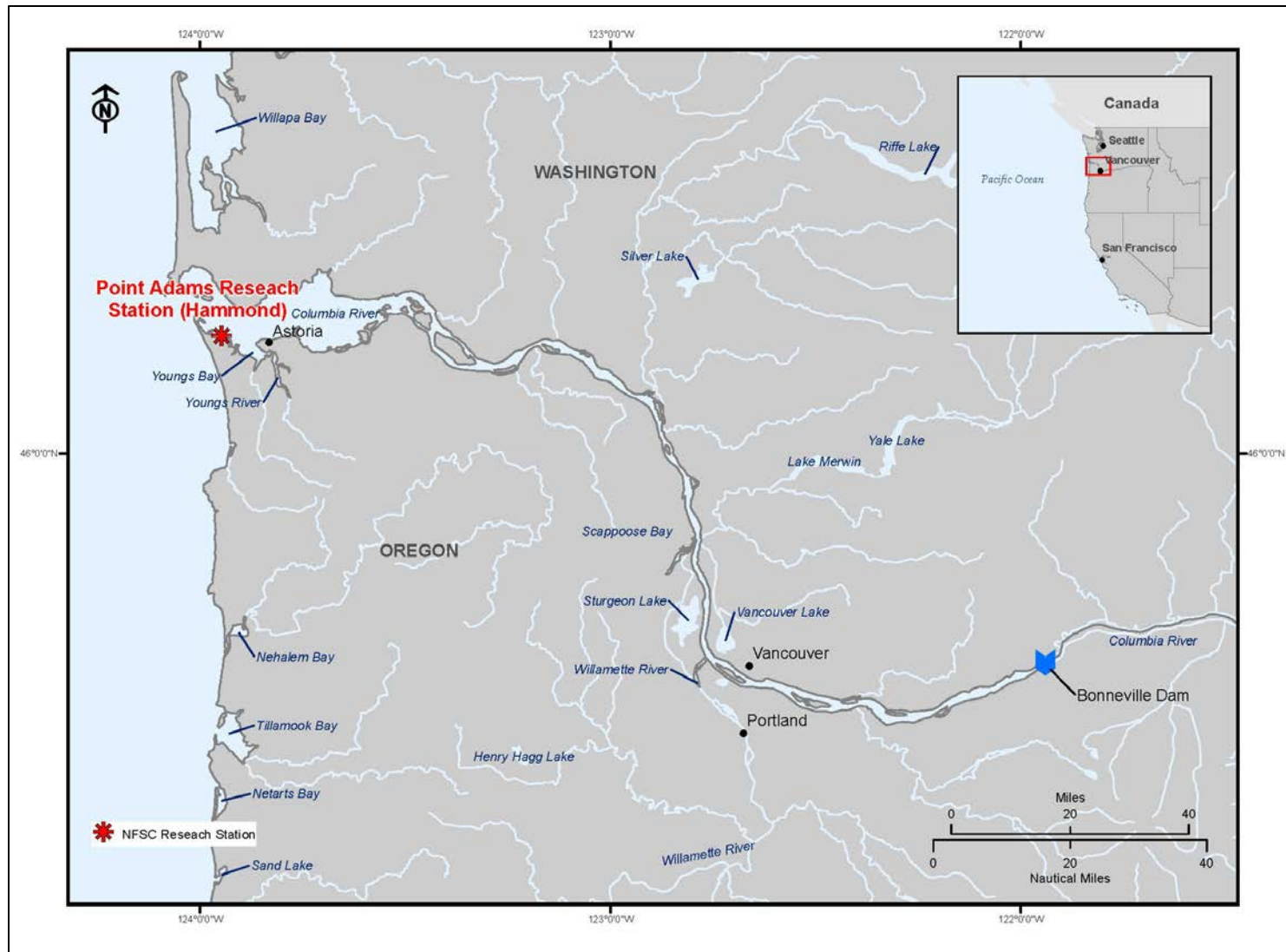


Figure 1.1-4 Lower Columbia River Research Area

1.1.2 Fishery Management Councils

To encourage a collaborative approach to fisheries management, the MSA established the nation's eight Regional Fishery Management Councils⁷. In the Pacific, the Pacific Fishery Management Council has jurisdiction for developing recommendations for fisheries in the exclusive economic zone off Washington, Oregon and California. The North Pacific Fishery Management Council is concerned with the waters around Alaska. The councils, which include fishing industry representatives, fishers, scientists, government agency representatives, federal appointees, tribal representatives, and others, are designed to provide all resource users and managers a voice in the fisheries management process. Under the MSA, the Councils are charged with developing and recommending Fishery Management Plans (FMPs) and management measures for the fisheries occurring within the EEZ adjacent to their constituent states. Data collected by Fisheries Science Centers are often used to inform decisions on FMPs, as well as to inform other policies and recommendations made by the Fishery Management Councils. Such policies and decisions sometimes affect areas that span the jurisdictions of several Fishery Management Councils, and make use of data provided by multiple Fisheries Science Centers.

In Washington State waters, the Washington Coastal Treaty Tribes are co-managers of fisheries with the State of Washington. In federal waters (beyond three miles off shore), the Coastal Treaty Tribes are co-managers with the federal government through the implementation of the Magnuson Stevens Fisheries Conservation Act (Magnuson-Stevens Act; 16 U.S. 1801 et seq.) by NMFS. This tribal/federal/state co-management framework has evolved as a reliable planning forum for all aspects of fishery management, including but not limited to planning harvest time, place and manner, and the need to constrain fishing mortality. The Pacific Fishery Management Council and NMFS are charged with the development, adoption, and implementation of FMPs under MSA. In implementing the requirements of the MSA, NMFS and the Council coordinate closely with the affected tribes to preserve and maintain marine resources for future generations.

1.1.3 Federal Tribal Obligations

The NWFSC regularly collaborates and consults with various tribes and tribal groups that may be interested in fisheries research in both marine and fresh waters. Many of these tribes have retained rights to access tribal resources; to fish, hunt and gather in perpetuity within their ceded territories. NWFSC seeks to engage directly as appropriate with Native American tribes when planning to conduct activities that either can impact tribal resources directly (e.g. removal of species within a tribe's usual and accustomed harvest areas), or indirectly through development and implementation of policies affecting tribal resources (elimination of research activities that currently inform tribal fishery management activities). The obligation of federal agencies to consult with Native American Tribes on activities that can potentially affect tribal rights and interests is based in treaties, case law, executive orders, executive memorandum and regulations. Regular consultation with tribes is required through Executive Order (EO) 12875 and 13175; both of these EO's direct federal agencies to consult with Native American tribes on a "government to government" basis when proposing to taking an action affecting tribal sovereignty, trust resources and tribal rights. As sovereigns, tribes are self regulatory and as such develop resource management plans for their respective resources including development of management plans and, regulations; and conduct a variety research activities to better understand the ecosystem where tribal fisheries are executed.

⁷ The eight Fishery Management Councils are New England, Mid-Atlantic, South Atlantic, Gulf of Mexico, Caribbean, Pacific, North Pacific, and Western Pacific.

Many inland tribes also have strong interests in marine and coastal issues because of anadromous fish species they value. The NWFSC regularly collaborates and consults with various tribes and tribal groups that may be interested in fisheries research in both marine and fresh waters. Additionally, there are a number of tribes that have commercial marine fisheries of whiting, rockfish, groundfish, and other species. Although there is not currently a specific tribal consultation requirement for Fishery Management Councils, the councils often engage in robust and substantial outreach efforts. Activities include community, tribal consortia, and other forums for meetings and outreach efforts that in many ways exceed the formal consultation requirements of federal agencies. All FMPs promulgated by the Pacific Fishery Management Council involve tribal fishing rights. Council fisheries are managed as part of a larger group of fisheries, in which management authority over tribal fisheries is effectively reserved by the tribes themselves, allowing tribal self-management and state-management to co-exist within a relationship of co-management. In addition, the MSA section 302(b)(5)(D) requires that the PFMC includes one representative and an alternate from a Native American tribe with federally recognized fishing rights from California, Oregon, Washington, or Idaho.

1.1.4 Marine Fisheries Commissions

In addition to providing information to domestic Fishery Management Councils, the NWFSC provides scientific advice to support several domestic and international fisheries commissions, including the Pacific States Marine Fisheries Commission (PSMFC), the International Pacific Halibut Commission (IPHC) and the Pacific Salmon Commission (PSC). Marine Fisheries Commissions were created in the recognition that fish do not adhere to political boundaries. In the Northwest, the PSMFC is a domestic organization that promotes and supports policies and actions to conserve, develop, and manage fishery resources in California, Oregon, Washington, Idaho and Alaska. Although the PSMFC has no regulatory or management authority, the commission serves a number of other functions vital to the sustainable utilization of marine fisheries, such as providing for collective participation for Pacific states to work on mutual concerns, and serving as a forum for discussion of fisheries resource issues that may fall outside of state, tribal or regional management council jurisdiction.

The International Pacific Halibut Commission (IPHC) is an international organization responsible for the preservation of the halibut fishery of the North Pacific Ocean and Bering Sea. The main functions of the IPHC are to conduct and coordinate scientific studies relating to the halibut fishery and to formulate regulations designed to develop the stocks of halibut to levels that permit optimal utilization. The IPHC submits regulations, including the total allowable catch of halibut, to the governments of the United States and Canada for approval. Upon approval, the regulations are enforced by the appropriate agencies of both governments. The NWFSC provides information to the IPHC to assist with the development of effective regulations.

The Pacific Salmon Commission is a sixteen-person body with four Commissioners and four alternates each from the United States and Canada, representing the interests of tribal treaty fisheries, commercial fisheries, and recreational fisheries as well as federal, state and tribal governments. Similar to the IPHC, the Pacific Salmon Commission provides regulatory advice and recommendations to the appropriate agencies in the United States and Canada. The commission has responsibility for all salmon originating in the waters of one country which are subject to interception by the other, affect management of the other country's salmon, or affect the biology of salmon stocks of the other country. In addition, the Pacific Salmon Commission is charged with taking into account the conservation of steelhead trout while fulfilling its other functions. NWFSC staff serve on scientific and technical committees of the Pacific Salmon Commission.

The Pacific Whiting Joint Management Committee was established under the 2003 Agreement between the Government of the United States of America and the Government of Canada on Pacific Hake/Whiting. The committee, which includes eight members (four appointed by each party), reviews advice from the Joint Technical Committee, Scientific Review Group and Advisory Panel and then

recommends the total allowable catch each year. The committee also provides direction to, and refers technical issues to, the Joint Technical Committee and Scientific Review Group. The NWFSC provides scientific and technical information to the Pacific Whiting Joint Management Committee, including contributions to stock assessments.

1.1.5 Role of Fisheries Research in Federal Fisheries Management

Fisheries managers use a variety of techniques to manage trust resources, a principal one being the development of FMPs. FMPs articulate fishery goals as well as the methods used to achieve those goals, and their development is specifically mandated under the MSA. The NWFSC provides scientific information and advice to assist with the development of FMPs prepared by the Pacific Fishery Management Council, the North Pacific Fishery Management Council, and other agencies.

Through its Regional Fisheries Science Centers, NMFS conducts both *fisheries-dependent* and *fisheries-independent* research on the status of living marine resources and associated habitats, which aids in the development of FMPs. Fisheries-dependent research is research that is carried out in partnership with commercial fishing vessels. The vessel activity is not directed by NMFS, but researchers collect data on the commercial catch. Fisheries-independent research is designed and conducted independent of commercial fishing activity to meet specific research goals. NMFS role in these activities varies and generally can be described as follows:

- Fishery-independent research directed by NWFSC scientists and conducted on board NOAA-owned and operated vessels or NOAA-chartered vessels.
- Fishery-independent research directed by cooperating scientists (other agencies, academic institutions, and independent researchers) conducted on board non-NOAA vessels but with financial and/or logistical support from NMFS and scientific collaboration.
- Fishery-dependent research conducted on board commercial fishing vessels, with or without NMFS scientists on board, but with financial and/or logistical support from NMFS.

The NWFSC conducts primarily fisheries-independent research on the status of living marine resources and associated habitats but also supports collaborative research and works with a wide spectrum of people from government agencies, universities, tribal agencies, as well as representatives of the fishing and hydropower industries, among many others. The NWFSC has cooperative research agreements with the University of Washington's College of Ocean and Fishery Sciences and with Oregon State University. NWFSC projects involve university faculty, post-doctoral fellows, student interns, and visiting university scientists from around the world.

Through Interagency Personnel Agreements the NWFSC regularly offers scientists from other institutions the opportunity to work at the NWFSC for one or two year periods. In addition, the NWFSC is currently conducting more than a dozen research projects in cooperation with Pacific Northwest Tribal organizations.

In several programs, the NWFSC partners with the owners of commercial fishing vessels, for instance, to help carry out NMFS coastwide surveys of the continental shelf and slope. NWFSC scientists work with scientists from other NOAA Fisheries regions, the Bonneville Power Administration, U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, Bureau of Land Management and intergovernmental agencies such as the PICES (the North Pacific Marine Sciences Organization).

The scope of NWFSC-affiliated fisheries and ecosystem research activities evaluated in this DPEA is described in Chapter 2. Research activities conducted by Fisheries Observers during the course of commercial fishing operations are not evaluated in this DPEA.

1.2 NWFSC FISHERIES RESEARCH ORGANIZATION

NWFSC research efforts are divided among four research divisions that are tasked with different roles in collecting scientific information on living marine resources and the ecosystems that sustain them. For more information, see the NWFSC website (<http://www.nwfsc.noaa.gov/research/index.cfm>).

Fishery Resource Analysis and Monitoring Division. The mission of the Fishery Resource Analysis and Monitoring (FRAM) Division is to provide the scientific basis for the management of West Coast Groundfish stocks and their ecosystems. This involves comprehensive analysis of data from fishery monitoring, fishery-independent resource surveys, and biological investigations. The results provide estimates of the current status and future trends in abundance and productivity of marine fishery resources, evaluations of the potential effects of fishery management alternatives on abundance and yield of living marine resources, and better information on fishery bycatch and other multi-species issues.

The West Coast groundfish fishery includes about 90 commercially fished stocks off Washington, Oregon and California. Analysis of stock assessment is critical to achieving sustainability in the West Coast groundfish fishery. Historically, shortcomings in the data (e.g., only landed catch monitored, only triennial surveys that do not cover all species, etc.) have resulted in uncertainty and associated controversy in assessments. To diminish the uncertainty associated with stock assessments, the FRAM division conducts annual groundfish surveys from the Canadian border to the Mexican border along the West Coast of the U.S. using chartered local commercial fishing vessels. These surveys are conducted with trawls outfitted with a suite of acoustic sensors to monitor trawl performance. The surveys provide robust information about distribution, relative abundance, and age structure of important groundfish populations to inform stock assessment models.

Since 2003 FRAM's Acoustics Team has been conducting the joint U.S.–Canada integrated acoustic and trawl surveys of Pacific hake (*Merluccius productus*) off the West Coast of North America (conducted in conjunction with the Southwest Fisheries Science Center as part of the Joint Pacific Hake and Sardine Integrated Acoustic Trawl Survey). Acoustics data are used to inform hake biomass estimates, which are then verified by trawl catches. These time-series surveys are the primary data source for the U.S.-Canada Pacific hake stock assessment, which uses age-structured assessment models to estimate current and future hake abundance. The assessments provide information to assist fishery managers in planning future harvests.

Fish Ecology Division. The Fish Ecology Division focuses on understanding the complex ecological linkages between commercially and recreationally important marine and anadromous fishery resources of the Pacific Northwest and their habitats. Particular emphasis is placed on investigation of the biotic and abiotic factors that control growth, distribution, and survival of important species and on the processes driving short-term and long-term population fluctuations. The Fish Ecology Division researches the migrational behavior and ecological processes that affect distribution, abundance, growth, and survival of anadromous and marine fishes in Pacific Northwest Coastal estuaries and marine waters.

Conservation Biology Division. The Conservation Biology Division focuses on the preservation of biological diversity found in living marine resources. Many of the challenges society faces regarding biodiversity and the protection of endangered species require the development of novel approaches for determining how human and natural factors influence the viability of marine species. To meet these challenges, the Division has assembled a group of biologists from a broad spectrum of scientific disciplines, including risk analysis, genetics, evolutionary biology, ecology, and population biology. As a group, the Conservation Biology Division is dedicated to conducting research necessary to help address critical conservation needs, with the primary focus on the recovery of ESA-listed Pacific salmon populations and depleted stocks of other marine species, including southern resident killer whales, eulachon, and several species of ESA-listed rockfish in Puget Sound.

Environmental and Fisheries Sciences Division. The Environmental and Fisheries Sciences Division conducts research to assess and reduce natural and human-caused impacts on environmental and human health, and to improve methods for fisheries restoration and production in conservation hatcheries and in aquaculture. Environmental health and conservation research examines environmental conditions and the impacts of chemical contaminants, marine biotoxins, and pathogens on fishery resources, protected species, habitat quality, seafood safety, and human health. Fisheries restoration and aquaculture includes research on the challenges associated with captive rearing, nutrition, reproduction, behavior, disease control, engineering, hatchery technology and larval/juvenile quality for protected, depleted and commercially valuable species.

1.3 PURPOSE AND NEED

Primary Action. This DPEA evaluates both a primary and a secondary action under the National Environmental Policy Act (NEPA). The primary action is the proposed performance of NWFSC fisheries and ecosystem research activities as described above and in Section 2.2. The purpose of this action is to produce scientific information necessary for the management and conservation of domestic and international living marine resources in a manner that promotes both the recovery of certain species and the long-term sustainability of these resources while generating social and economic opportunities and benefits from their use. The information provided by NWFSC fisheries research activities is essential to the development of a broad array of fisheries management actions taken not only by NMFS, but also by other federal, state, and international authorities.

The ultimate goal of NWFSC fisheries and other research activities is to provide the scientific basis for conservation and management of living marine resources and their habitat with emphasis on the Pacific Northwest. In order to achieve this, the NWFSC needs to perform its research activities through a suite of programs that generate the scientific information necessary to inform management of the region's marine and anadromous fish and invertebrate populations and their habitats to ensure they remain at sustainable and healthy levels.

Secondary Action. A secondary, related action — also called a “connected action” under NEPA (Sec. 1508.25) — is the issuance of proposed regulations and subsequent Letters of Authorization (LOA) under Section 101(a)(5)(A) of the MMPA of 1972, as amended (MMPA; 16 United States Code [U.S.C.] 1361 *et seq.*) that would govern the unintentional taking of small numbers of marine mammals incidental to the NWFSC’s research activities.

Sections 101(a)(5)(A) and (D) of the MMPA direct the Secretary of Commerce (Secretary) to allow, upon request, the incidental, but not intentional taking of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if certain findings are made and regulations are issued or, if the taking is limited to harassment, a notice of a proposed authorization is provided to the public for review. Take, under the MMPA means “to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal.” The MMPA defines “harassment” as “any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harassment]; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [Level B harassment]”.

Under the MMPA, any activities resulting in the take of marine mammals must be authorized by NMFS; this includes research programs conducted by the NMFS Fisheries Science Centers. Because the NWFSC’s research activities have the potential to take marine mammals by Level A and B harassment, serious injury and/or mortality, the NWFSC is applying to NMFS for an incidental take authorization (ITA) for its fisheries and ecosystem research programs. Authorization for incidental takes shall be granted if NMFS finds that the taking will have a negligible impact on the species or stock(s), will not

have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses (where relevant), and if the permissible methods of taking and requirements pertaining to the mitigation, monitoring and reporting of such takings are set forth.

The purpose of issuing ITAs is to authorize take that is otherwise prohibited by the MMPA and to ensure that the action complies with the MMPA and NMFS implementing regulations. ITAs may be issued as either: (1) regulations and associated LOAs under Section 101(a)(5)(A) of the MMPA; or (2) an Incidental Harassment Authorization under Section 101(a)(5)(D) of the MMPA, which can only be issued when there is no potential for serious injury and/or mortality or where any such potential can be negated through required mitigation measures. Because there is a potential for lethal takes and takes that may result in serious injury that could lead to mortality, the NWFSC is requesting rulemaking and the issuance of LOAs for this action.

This DPEA analyzes the environmental impacts associated with the proposed authorization of the take of marine mammals incidental to the NWFSC's conduct of fisheries research activities in the California Current area of the Pacific Ocean and in the estuaries associated with Puget Sound and the lower Columbia River below the Bonneville Dam. It also analyzes a reasonable range of mitigation alternatives that may be required if NMFS issues an MMPA authorization. The analysis of mitigation measures includes the consideration of benefits to the affected species or stocks and their habitat, and an analysis of the practicability and efficacy of each measure. This analysis of mitigation measures could potentially be used to support requirements pertaining to mitigation, monitoring, and reporting specified in MMPA regulations and subsequent LOAs, if issued.

Further, because the proposed research activities occur in known habitat areas for marine species that are listed as threatened or endangered under the Endangered Species Act⁸ (hereafter termed "ESA-listed species"), this DPEA evaluates the potential impacts to ESA-listed marine species that may result from either the primary or secondary action. This information will be used to initiate consultation with NMFS and the U.S. Fish and Wildlife Service under section 7 of the ESA. Likewise, because the proposed research activities occur partially within the boundaries of National Marine Sanctuaries, and within areas identified as Essential Fish Habitat (EFH), this DPEA evaluates potential impacts to sanctuary resources and EFH as required under section 304(d) of the National Marine Sanctuaries Act and section 305(b)(2) of the MSA. The NWFSC intends to use this DPEA as the basis for consultations with the appropriate offices and agencies in compliance with these and other applicable laws (Table 1.6-1).

1.4 SCOPE AND ORGANIZATION OF THIS DPEA

In considering the proposed action, NMFS is responsible for complying with a number of federal statutes, regulations, and executive orders, including NEPA, as well as tribal treaties regarding timely notice and participation in decisions affecting these tribes. As such, the purpose of the DPEA is to provide an environmental analysis to support the NMFS proposal to continue the research activities under the requirements of an LOA and to encourage and facilitate public involvement in the environmental review process.

Under NEPA, an EA is prepared to determine if any significant environmental impacts are likely to be caused by a proposed action. If the EA does not identify significant impacts, a Finding of No Significant Impacts (FONSI) is prepared to document the decision maker's determination and to approve the proposed action. If at any time during preparation of the EA it appears that significant impacts would result from the proposed action, the agency would halt development of the EA and begin preparation of an Environmental Impact Statement (EIS) to more thoroughly evaluate the potential impacts and potential

⁸ 16 U.S.C. §1531 et seq.

ways to reduce or mitigate those impacts. Thus, while the EA objectively evaluates the full extent of potential impacts of a proposed action (from minor to major, adverse or beneficial, short-term to long-term – see discussion below), the FONSI provides the decision maker’s rationale with regard to the significance of those impacts.

This DPEA provides a programmatic-level assessment of the potential impacts on the human environment associated with the proposed NWFSC research programs. A programmatic approach is used when initiating or re-evaluating a federal program for NEPA compliance. It takes a broad look at issues and alternatives (compared to documents for a specific project or action), and provides a baseline for future management actions. Programmatic documents are often intended to provide NEPA compliance for management and other activities over a fixed period before a formal review is again initiated.

This DPEA assesses not only the potential direct and indirect impacts of the alternatives presented to the physical, biological and socioeconomic systems in the NWFSC area of responsibility, but also the potential impacts to the management processes that are used to monitor the health of the resources, develop plans to manage the resources to balance recovery goals and socioeconomic goals, and ensure the sustainability of the resources and affected fishing communities.

The chapters that follow describe the proposed research activities and potential alternatives considered (Chapter 2), the affected environment as it currently exists (Chapter 3), the probable direct and indirect consequences on the human environment that may result from the implementation of the proposed research activities and their alternatives (Chapter 4), and the potential contribution to cumulative impacts from the proposed activities and their alternatives (Chapter 5).

The scope of this DPEA covers research activities conducted by the NWFSC or its research partners that meet one or more of the following criteria:

- Contribute to fishery management and ecosystem management responsibilities of NMFS under U.S. law and international agreements.
- Take place in marine and estuarine waters of the Pacific Ocean, Puget Sound, and the lower Columbia River below Bonneville Dam.
- Involve the transiting of these waters in research vessels, observational surveys made from the decks of those vessels (e.g., marine mammal and seabird transects that do not involve directed research permits), the deployment of fishing gear and scientific instruments into the water in order to sample and monitor living marine resources and their environmental conditions, and/or use active acoustic devices for navigation and remote sensing purposes.
- Have the potential to interact adversely with marine mammals and protected species of fish, turtles, birds, and invertebrates. However, the research activities covered under this DPEA involve only *incidental* interactions with protected species, not *intentional* interactions with those species. The primary focus of this DPEA is on fisheries-related research but several other types of ecosystem surveys are also included because they deploy fishing gear and other instruments similar to those used in fisheries research in order to monitor the environment important to protected species and therefore involve the same potential risks of incidental interactions with protected species.
- The DPEA covers both short-term and long-term NWFSC fisheries research projects of limited size and magnitude and where cumulative effects are deemed negligible. Therefore, information within the DPEA would inform the issuance of a scientific research permit to conduct NWFSC fisheries research. However, any information not included in this DPEA may need to be captured in a supplemental EA.

This DPEA does **NOT** cover:

- Many directed research projects on protected species, such as studies involving intentional capture or pursuit of marine mammals or ESA-listed fish species for tagging, tissue sampling, or other intentional takes which require special research permits under the MMPA or ESA which involve their own environmental review processes and consultations under applicable regulations. However, this DPEA does include some research activities that have associated ESA Section 10 permits for research involving ESA-listed salmon and other fish. Such directed research permits may not cover unintentional effects on other protected species, e.g., marine mammals, which is a focus of this DPEA.
- The potential effects of research conducted by scientists in other NMFS Science Centers.
- Other activities of the NWFSC that do not involve the deployment of vessels or gear in marine waters, such as research activities conducted in freshwater and terrestrial environments, evaluations of socioeconomic impacts related to fisheries management decisions, taxonomic research in laboratories, fisheries enhancements such as hatchery programs, and educational outreach programs.
- Implementation of the West Coast Fisheries Observer Program. The impacts of the Fisheries Observer Program are considered under Fishery Management Plan NEPA processes.
- Other fisheries research programs conducted and funded by other agencies, academic institutions, non-governmental organizations, and commercial fishing industry research groups without material support from the NWFSC.

In the future, research activities of the NWFSC will be evaluated to determine if they are consistent with the type and scope of research covered under this DPEA. Some of these proposed projects may require further environmental impact assessment or satisfaction of other consultation, approval, or permitting requirements before being allowed to proceed (see also Section 2.3.4). In particular, proposed projects that may impact protected species and require permits under the ESA or the MMPA may require individual NEPA analyses and decisions tiered off this DPEA. After new projects are sufficiently well defined and their potential environmental consequences are understood, specific impacts would be evaluated as necessary. If the proposed new research activities are not within or similar to the range of alternatives addressed in the programmatic document and may have adverse environmental impacts that are not within the scope of the analysis in this DPEA, additional NEPA review would be required.

In developing this DPEA, NMFS adhered to the procedural requirements of NEPA; the Council on Environmental Quality (CEQ) regulations for implementing NEPA (40 Code of Federal Regulations (CFR) 1500-1508)⁹, and NOAA's procedures for implementing NEPA¹⁰.

The following definitions will be used to characterize the nature of the various impacts evaluated with this DPEA:

- **Short-term or long-term impacts.** These characteristics are determined on a case-by-case basis and do not refer to any rigid time period. In general, short-term impacts are those that would occur only with respect to a particular activity or for a finite period. Long-term impacts are those that are more likely to be persistent and chronic.
- **Direct or indirect impacts.** A direct impact is caused by a proposed action and occurs contemporaneously at or near the location of the action. An indirect impact is caused by a

⁹ See Reference (CEQ 1969).

¹⁰ NOAA Administrative Order 216-6, Environmental Review Procedures for Implementing the National Environmental Policy Act.

proposed action and might occur later in time or be farther removed in distance but still be a reasonably foreseeable outcome of the action. For example, a direct impact of erosion on a stream might include sediment-laden waters in the vicinity of the action, whereas an indirect impact of the same erosion might lead to lack of spawning and result in lowered reproduction rates of indigenous fish downstream.

- **Minor, moderate, or major impacts.** These relative terms are used to characterize the magnitude of an impact. Minor impacts are generally those that might be perceptible but, in their context, are not amenable to measurement because of their relatively minor character. Moderate impacts are those that are more perceptible and, typically, more amenable to quantification or measurement. Major impacts are those that, in their context and due to their intensity (severity), have the potential to meet the thresholds for significance set forth in CEQ regulations (40 CFR 1508.27) and, thus, warrant heightened attention and examination for potential means for mitigation to fulfill the requirements of NEPA.
- **Adverse or beneficial impacts.** An adverse impact is one having adverse, unfavorable, or undesirable outcomes on the man-made or natural environment. A beneficial impact is one having positive outcomes on the man-made or natural environment. A single act might result in adverse impacts on one environmental resource and beneficial impacts on another resource.
- **Cumulative impacts.** CEQ regulations implementing NEPA define cumulative impacts as the “impacts on the environment which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions.” (40 CFR 1508.7) Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time within a geographic area.

1.5 PUBLIC REVIEW AND COMMENT

Public participation is a cornerstone of the NEPA process. In preparing EAs, federal agencies must involve environmental agencies, applicants, and the public to the extent practicable (40 CFR Sec. 1501.4 [b]). Following guidance for public review of EAs in NOAA Administrative Order 216-6 (Sections 5.02b.1 and 5.03e.2), this DPEA and the associated LOA application will be available for public review on the World Wide Web, and notice of the availability of the DPEA will be published in *Federal Register*. Public comments received on this DPEA will be considered in preparation of the Final Programmatic Environmental Assessment.

1.6 REGULATORY REQUIREMENTS

NMFS is the lead federal agency for the proposed research activities evaluated in this DPEA. These activities trigger a broad range of regulatory issues because they may cause adverse impacts to public resources regulated by various statutes, and contribute to reducing impacts caused by other activities, such as fishing, that are also regulated by those same statutes. Chapters 4 and 5 assess the impacts of the research activities on protected species and habitat. Because these research activities are necessary for NMFS to carry out its regulatory mandates, Chapters 4 and 5 also describe potential impacts to NMFS ability to effectively monitor and manage fishery resources under the alternatives evaluated. Descriptions of the relevant statutory requirements are provided in Chapter 6, “*Applicable Laws*.”

Table 1.6-1, below, presents a brief summary of some of the applicable laws and treaties. This information is provided to aid the reader in understanding the material presented later in the DPEA and is not intended to be a complete listing of all applicable statutes, orders or regulations applicable to the proposed action and alternatives.

Table 1.6-1 Applicable Laws and Treaties

Law	Description
National Environmental Policy Act (NEPA)	Requires federal agencies to evaluate potential environmental effects of any major planned federal action and promotes public awareness of potential impacts by requiring federal agencies to prepare an environmental evaluation for any major federal action affecting the human environment.
Magnuson-Stevens Fishery Conservation and Management Act (MSA)	Authorizes the U.S. to manage fishery resources in an area from a state's territorial sea (extending 3nm from shore) to 200 nm off its coast (termed as the Exclusive Economic Zone [EEZ]). Includes 10 National standards to promote domestic commercial and recreational fishing under sound conservation and management principles, and provide for the preparation and implementation of fishery management plans (FMP's).
Marine Mammal Protection Act (MMPA)	Prohibits the take of marine mammals in U.S. waters and by U.S. citizens on the high seas and the importation of marine mammals and marine mammal products into the U.S. Allows, upon request, the "incidental," but not intentional, taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing).
Endangered Species Act (ESA)	Provides for the conservation of endangered and threatened species of fish, wildlife, and plants. Administered jointly by NMFS and the USFWS.
Migratory Bird Treaty Act (MBTA)	Protects approximately 836 species of migratory birds from any attempt at hunting, pursuing, wounding, killing, possessing, or transporting any migratory bird, nest, egg, or part thereof, unless permitted by regulations.
Fish and Wildlife Coordination Act (FWCA)	Requires USFWS and NMFS to consult with other state and federal agencies in a broad range of situations to help conserve fish and wildlife populations and habitats in cases where federal actions affect natural water bodies.
Pacific Salmon Treaty Act (PSTA)	The Pacific Salmon Treaty Act -- Public Law 99-5, approved March 15, 1985, (16 U.S.C. 3631) implements the Pacific Salmon Treaty between the U.S. and Canada, January 28, 1985; establishes the requirements for Commissioners and the subsidiary Northern, Southern, and Fraser River Panels; and authorizes federal regulatory preemption by the Secretary of Commerce to meet treaty obligations. The Act authorized creation of an advisory committee to assist the U.S. Section and U.S. Panel Sections, and authorizes appropriations of such sums as may be necessary for carrying out the purposes and provisions of the Treaty and Act.
National Historic Preservation Act (NHPA)	Section 106 requires review of any project funded, licensed, permitted, or assisted by the federal government for impact on significant historic properties.
Executive Order 12989, Environmental Justice	Directs federal agencies to identify and address disproportionately high and adverse effects of federal projects on the health or environment of minority and low-income populations to the greatest extent practicable and permitted by law.
Marine Protection, Research, and Sanctuaries Act	Prohibits ocean dumping from any U.S. vessel and established coastal water quality research and monitoring programs. Also authorizes the Secretary of Commerce to designate and protect areas of the marine environment with special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archeological, educational, or esthetic qualities as national marine sanctuaries. Section 304(d) requires interagency consultation between the NOAA Office of National Marine Sanctuaries (ONMS) and federal agencies taking actions that are "likely to destroy, cause the loss of, or injure a sanctuary resource."
Executive Order 13158, Marine Protected Areas	The purpose of this order is to strengthen and expand the Nation's system of marine protected areas (MPAs). It encourages federal agencies to use science-based criteria and protocols to identify and prioritize natural and cultural resources in the marine environment that should be protected to secure valuable ecological services and to monitor and evaluate the effectiveness of MPAs. Each federal agency whose actions affect the natural or cultural resources that are protected by an MPA shall identify such actions. To the extent permitted by law and to the maximum extent practicable, each federal agency, in taking such actions, shall avoid harm to the natural and cultural resources that are protected by an MPA.
Coastal Zone Management Act (CZMA)	Encourages and assists states in developing coastal management programs. Requires any federal activity affecting the land or water use or natural resources of a state's coastal zone to be consistent with that state's approved coastal management program.

Law	Description
Tribal Treaties, Case Decisions, and Executive Order 13175, Consultation and Coordination with Indian Tribal Governments	<p>Native American tribes are seen as dependent sovereign nations and the U.S. government has trust relationship with these tribe that vary depending on the underlying treaties, statutes, and agreements creating the duty. EO 13175 directs federal agencies to consult with Native American tribes and to respect tribal sovereignty when tribal rights may be affected. In the 1850's, the U.S. negotiated a series of treaties with Northwest Indian tribes. The tribes ceded land, and assumed designated tribal lands. At the same time, the tribes did not cede, rather they retained, their rights to hunt and gather in open and unclaimed lands, and fish in their usual and customary places. While some of these treaties have been challenged in court the rights of the tribes to hunt and fish have been upheld in considerable case law, including U.S. Supreme Court decisions.</p>

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2.1 INTRODUCTION

The Council on Environmental Quality (CEQ) is responsible for the development and oversight of regulations and procedures implementing the National Environmental Policy Act (NEPA). The CEQ regulations provide guidance for federal agencies regarding NEPA's requirements (40 Code of Federal Regulations [CFR] Part 1500). National Oceanic and Atmospheric Administration (NOAA) has also prepared environmental review procedures for implementing NEPA, NOAA Administrative Order 216-6 (NAO 216-6). Section 5.03b of NAO 216-6 states: "An Environmental Assessment [EA] must consider all reasonable alternatives, including the preferred action and the no action alternative."

To warrant detailed evaluation by the National Marine Fisheries Service (NMFS), an alternative must be reasonable¹¹ and meet the purpose and need (see Section 1.3). Screening criteria are used to determine whether an alternative is reasonable and should be considered further or whether it is not reasonable to consider in detail in the DPEA. Section 2.6 describes potential alternatives that were considered but rejected because they do not meet the purpose and need of the proposed action.

Screening Criteria. To be considered 'reasonable' for the purposes of this Draft Programmatic Environmental Assessment (DPEA), an alternative must meet the following criteria:

1. The action must not violate any federal statute or regulation.
2. The action must be consistent with reasonably foreseeable funding levels.
3. The action must be consistent with long-term research commitments and goals to maintain the utility of scientific research efforts, or consider no federal funding availability for fisheries research.

To maintain the utility of scientific research efforts, fisheries and marine ecosystem scientific research activities should address at least some of the following goals related to fisheries management:

1. Methods and techniques must provide standardized and objective data consistent with or complementary to past data sets (time series) in order to facilitate long-term trend analyses.
2. Collected data must adequately characterize living marine resource and fishery populations and the health of their habitats.
3. The surveys must enable assessment of population status and provide predictive capabilities required to respond to changing ecosystem conditions and manage future fisheries.
4. Research on new methodologies to collect fisheries and ecosystem information (e.g. active and passive acoustic instruments and video surveys of benthic habitats in lieu of bottom trawls), and research oriented toward modifications of fishing gear to address bycatch or other inefficiencies must be conducted with experimental controls sufficient to allow statistically valid comparisons with relevant alternatives.

NMFS evaluated each potential alternative against these criteria and requirements. Based on this evaluation, the No-Action/Status Quo alternative and two other action alternatives were identified as reasonable and are carried forward for more detailed evaluation in this DPEA. NMFS also evaluates a

¹¹ "Section 1502.14 (NEPA) requires the DPEA/Environmental Impact Statement (EIS) to examine all reasonable alternatives to the proposal. In determining the scope of alternatives to be considered, the emphasis is on what is 'reasonable' rather than on whether the proponent or applicant likes or is itself capable of carrying out a particular alternative. Reasonable alternatives include those that are *practical or feasible from the technical and economic standpoint and using common sense*, rather than simply desirable from the standpoint of the applicant." (40 Questions) (emphasis added)

second type of no-action alternative that considers no federal funding for fisheries research activities. This alternative is called the No Research Alternative to distinguish it from the No-Action/Status Quo alternative.

The No-Action/Status Quo Alternative is used as the baseline for comparison of the other alternatives. Three of the alternatives include fisheries and ecosystem research projects conducted or funded by the Northwest Fisheries Science Center (NWFSC) as the primary federal action. These three alternatives also include suites of mitigation measures intended to minimize potentially adverse interactions with protected species. Protected species include all marine mammals, which are covered under the Marine Mammal Protection Act (MMPA), all species listed under the Endangered Species Act (ESA), and bird species protected under the Migratory Bird Treaty Act (MBTA).

The three alternatives involving research activities in the marine environment trigger marine mammal protection requirements under the MMPA. For this reason, NMFS must evaluate the alternatives to ensure that they would fulfill the purpose and need of NMFS issuing regulations and subsequent Letters of Authorization (LOA) under Section 101(a)(5)(A) of the MMPA to the NWFSC, which is the secondary federal action considered in this DPEA. The promulgation of regulations and subsequent issuance of LOAs, if implemented, would provide authorization under the MMPA to the NWFSC for take of marine mammals incidental to the conduct of the NWFSC's research activities, namely: (1) the issuance of an LOA for the take of marine mammals by Level A and Level B harassment, and by serious injury or mortality incidental to the NWFSC's conduct of research activities for a period of up to five years; and (2) compliance with the MMPA which sets forth specific findings (e.g. no unmitigable adverse impact on the availability of a species or stock for subsistence uses, negligible impact on a species or stock) and prescriptions (mitigation, monitoring, and reporting requirements) that must be made in order for NMFS to issue LOAs. In order to authorize incidental take of marine mammals under the MMPA, NMFS must identify and evaluate a reasonable range of mitigation measures to minimize impacts to marine mammals to the level of least practicable adverse impact. This range of mitigation measures has been incorporated as part of the identified alternatives in order to evaluate their ability to minimize potential adverse environmental impacts. The efficacy and practicability of all potential mitigation measures is assessed in Chapter 4.

Further, because the proposed research activities occur in known habitat areas of species that are listed as threatened or endangered under the ESA, this DPEA evaluates potential impacts to ESA-listed species and designated critical habitat that may result from either the primary or secondary action. Likewise, because the proposed research activities occur partially within the boundaries of National Marine Sanctuaries, and within areas identified as Essential Fish Habitat (EFH), this DPEA evaluates potential impacts to sanctuary resources and EFH as required under section 304(d) of the National Marine Sanctuaries Act and section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA).

**2.2 ALTERNATIVE 1 – NO-ACTION/STATUS QUO ALTERNATIVE - CONDUCT
FEDERAL FISHERIES AND ECOSYSTEM RESEARCH WITH SCOPE AND
PROTOCOLS SIMILAR TO PAST EFFORT**

As discussed in Chapter 1, the NWFSC collects a wide array of information necessary to evaluate the status of fishery resources and the marine environment. NWFSC scientists conduct fishery-independent research onboard NOAA owned and operated vessels or on chartered vessels in three geographic research areas: the California Current Research Area (CCRA), the Puget Sound Research Area (PSRA), and the Lower Columbia River Research Area (LCRRA). Under the Status Quo Alternative, the NWFSC would administer and conduct 34 research programs during the MMPA authorization period, as summarized in Table 2.2-1. Appendix A provides an illustrated description of the fishing gear and scientific instruments used during NWFSC research. Under this alternative, the NWFSC would continue to apply for section 10 directed research permits for the intentional take of ESA-listed species and Scientific Research Permits (SRPs) for research that will affect MSA species managed under FMPs.

2.2.1 NWFSC Research Activities under the Status Quo Alternative

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Table 2.2-1 Summary Description of NWFSC Surveys and Research Projects Conducted on NOAA Vessels and NOAA-chartered Vessels under the Status Quo Alternative

See Appendix A for descriptions of the different gear types and vessels used. Appendix B includes figures showing the spatial/temporal distribution of fishing gears used during NWFSC research. Mitigation measures are described in Section 2.2.1. Abbreviations used in the table: CTD = Conductivity Temperature Depth; DAS = days at sea; cm2 = square centimeter; freq = frequency; ft = feet; hrs = hours; in = inch; kHz = kilohertz; km = kilometer; kts = knots; L = liter; m = meter; m3 = cubic meter; max = maximum; MHz = megahertz; mi = miles; min = minutes; mm = millimeter; NA = Not Available or Not Applicable; nm = nautical miles; TBD = to be determined; v = volt; yr = year; ~ = approximately.

Survey Name	Survey Description	General Area of Operation	Season, Frequency, Yearly Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
CALIFORNIA CURRENT RESEARCH AREA								
Studies Using Trawl Gear								
Bycatch Reduction Research	Research effort to test gear improvements to reduce bycatch of non-target fish species. Current examples include testing low-rise bottom trawls, flexible sorting grates in bottom and midwater trawls, and open escape window bycatch reduction devices in midwater trawls. Operates with ESA section 10 permit for directed research on listed fish species.	Southern Oregon to Canada	April - October, Intermittent, 30-90 DAS Daytime operations only	Chartered commercial fishing vessels	Bottom trawl	Net type: Commercial bottom trawls Net size: Varies Tow speed: 1.5-3.5 knots (kts) Duration: up to 4 hours (hrs) Depth: 50-1000 meters (m)	40 bottom trawls/year (yr)	Standard Avoidance: Vessel captains and bridge crew watch for marine mammals and sea turtles while underway, especially where concentrations of protected species are observed, and take action to avoid collisions if possible. Move-on Rule: Vessel captains, Chief Scientists, and/or designated members of the scientific party visually monitor the area for protected species at least 10 min before and during the set. If marine mammals are too close to the ship or look like they are closing, gear deployment is delayed until the animals leave or the sampling station is moved. If protected species are sighted during the set, set duration, retrieval time, and vessel speed are adjusted as needed to minimize the risk of incidental take (see Section 2.2.2).
					Midwater trawl	Net type: Commercial pelagic trawls Net size: Varies Tow speed: 1.5-3.5 kts Duration: up to 8 hrs but average 2 hrs Depth: 50-1000 m	up to 60 midwater trawls/yr	
					Bottom trawl	Net type: Double rigged shrimp trawl Net size: Varies Tow speed: 1.5-3.5 kts Duration: 30-80 minutes (min) Depth: 100-300 m	up to 60 shrimp trawls/yr	
					Various models of echosounders and sonars	38-200 kHz; ≤ 224 dB/1μPa	Continuous during cruise	
Camera Trawl Research <i>(associated with hake acoustic survey)</i>	Research and development and pilot surveys to refine the development of optical-trawl samplers as applied to acoustical and other surveys, including testing of hardware and software, to assess abundance and species composition in trawls used to sample commercially important groundfish along the U.S. West Coast.	Southern California to Southeast Alaska, including Canada	Annually since 2011, March-Sept, 30-70 DAS Daytime operations only	NOAA Ship R/V <i>Bell M. Shimada</i> and charter commercial fishing vessel	Midwater trawl	Net type: Aleutian Wing Midwater Trawl; Net size: headrope 334 ft Tow speed: 2.8-3.5 kts Duration: variable Depth: down to 500 m	75 trawls/yr (in addition to trawls conducted as part of hake survey)	Standard avoidance and move-on rule.
Groundfish Bottom Trawl Survey <i>(Under the Preferred Alternative a camera is added to the bottom</i>	Fisheries independent survey to monitor groundfish distribution and biomass along the U.S. West Coast at depths of 55 to 1280 m. Operates with ESA section 10 permit for directed research on listed fish	U.S./Mexico to U.S./Canada border	Annually, May to October, at least 190 DAS Daytime operations only	Charter, four commercial trawlers	Bottom trawl	Net type: modified Aberdeen bottom trawl Net size: mouth opening 5 x 15 m Tow speed: 2.2 kts Duration: 15 min Depth: 55-1280 m	737-773 trawls/yr	Standard avoidance and move-on rule.

Survey Name	Survey Description	General Area of Operation	Season, Frequency, Yearly Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
trawl net)	species.				Various models of echosounders and sonars	27-200 kHz; ≤ 224 dB/1μPa	Continuous during cruise	
					CTD profiler	Gear Type: Sea-Bird SBE 19+ conductivity, temperature, depth profiler equipped with SBE 43 type oxygen sensor; Surface to near bottom and along tow track	737-773 casts/yr	
Hake Acoustic Survey	Measures the abundance of hake using acoustic gear and trawl to confirm identification of fish targets. Use of broadband acoustics to assist in classifying mixed schools acoustically. Operates with ESA section 10 permit for directed research on listed fish species.	Southern California to Southeast Alaska, including Canada, following the hake	Annually, June- Sept, 60-80 DAS Daytime operations only	NOAA Ships R/V <i>Miller Freeman</i> (no longer in use) or R/V <i>Bell M. Shimada</i>	Midwater trawl	Net type: Aleutian Wing Midwater Trawl Net size: headrope 334 ft Tow speed: 2.8-3.5 kts Duration: variable Depth: variable	150 trawls/yr	Standard avoidance and move-on rule.
					Bottom trawl	Net type: Poly Nor’easter Bottom Trawl (PNE) Net size: footrope 120 ft, headrope 89 ft Tow speed: 2.8-3.5 kts Duration: variable Depth: variable	5-10 trawls/yr	
					Various models of echosounders and sonars	1.5-200 kHz; ≤ 224 dB/1μPa	Continuous during cruise	
					CTD profiler	Gear Type: Sea-Bird SBE 19+ conductivity, temperature, depth profiler equipped with SBE 43 type oxygen sensor; Surface to near bottom and along tow track	150 casts/yr	
Juvenile Salmon PNW Coastal Survey <i>(Under the Preferred Alternative a marine mammal excluder device is added to the Nordic 264 trawl net)</i>	Assesses Pacific Northwest Coastal ocean condition and the growth, relative abundance, and survival of juvenile salmon during their first summer at sea.	Newport, OR to Cape Flattery, WA in Continental shelf waters	May, June, and September, annually, 36 DAS (roughly divided equally between May, June and Sept) Daytime operations only	Charter commercial fishing vessel	Surface trawl	Net type: Nordic 264 surface trawl Net size: 30 m wide x 20 m deep Tow speed: 3-4 kts Duration: 30 min Depth: surface down to 30 m 4 acoustic pingers attached to the net	180 trawls/yr	Standard avoidance and move-on rule. Typically two models of pingers with different frequencies are used on each net to deter small cetaceans.
					CTD profiler and rosette water sampler	Gear Type: Sea-Bird SBE 19+ and SBE 23 CTDs Deployment: Vertical drop Depth: Surface to near bottom or 200 m max.	180 samples/yr	
					Bongo net	Net type: Bongo plankton net with 335 μm mesh Net size: two 0.6 m diameter nets Tow speed: 3 kts Tow Duration: 5-6 min Depth: 0-30 m	180 samples/yr	

Survey Name	Survey Description	General Area of Operation	Season, Frequency, Yearly Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
					Vertical plankton net	Net type: ring net with 202 µm mesh Net size: 0.5 m diameter Tow speed: 0 (vertical tow) Duration: 5-6 min Depth: Surface to near bottom or 100 m max	180 samples/yr	
					Water pump	Gear type: Continuous water pump with SBE-45 MicroTSG Thermosalinograph Depth: 3 m	Continuous during cruise	
					Simrad EK60 Multi-frequency echosounder (2010-2012 only)	38, 70, 120, and 200 kHz; 228 dB/1µPa	Continuous during cruise	
Northern Juvenile Rockfish Survey	Measures the spatial abundance of juvenile fishes in coastal marine waters of the northern California Current ecosystem as an index of groundfish recruitment potential	Cape Mendocino, CA to Cape Flattery, WA	Annually, May- June, 15-30 DAS Night operations only	Charter commercial fishing vessel	Midwater trawl	Net type: Modified Cobb trawl with 9.5 mm codend Net size: 12 x 12 m opening, 26 m headrope Tow speed: 2.7 kts Duration: 15 min Depth: 30-40 m	100 trawls/yr	Standard avoidance and move-on rule.
					CTD profiler	Tow speed: 0 Duration: 20-120 min	100 samples/yr	
					Various plankton nets (Bongo and Tucker)	Tow speed: 1.5- 2.5 kts Duration: 20-60 min	100 samples/yr	
					Simrad EK60 Multi-frequency echosounder	38, 70, 120, and 200 kHz; 228 dB/1µPa	Continuous during cruise	
PNW Ichthyo-plankton Survey <i>(Survey not continued in the Preferred Alternative)</i>	Measures the temporal variation in abundance of juvenile fishes in coastal marine waters of the Pacific Northwest	Heceta Head, OR to Willapa Bay, WA in Continental shelf waters	Annually, May through September, 20 DAS Daytime operations only	Charter commercial fishing vessel	Midwater trawl	Net type: Nordic 264 surface trawl Net size: 30 m wide x 20 m deep Tow speed: 3 kts Duration: 30 min Depth: 30-50 m	40 trawls/yr	Standard avoidance and move-on rule. Typically two models of pingers with different frequencies are used on each net to deter small cetaceans.
					Surface trawl	Net type: Nordic 264 surface trawl Net size: 30 m wide x 20 m deep Tow speed: 3 kts Duration: 30 min Depth: up to 30 m	80 trawls/yr	
PNW Piscine Predator and Forage Fish Survey <i>(Survey not continued in the Preferred Alternative)</i>	Measures the presence and abundance of piscine predators and forage fish species in Pacific Northwest waters.	Mouth of the Columbia River to Willapa Bay in Continental shelf waters	Biweekly April to August, 16 DAS Daytime operations only	Charter commercial fishing vessel	Surface trawl	Net type: Nordic 264 surface trawl Net size: 30 m wide x 20 m deep Tow speed: 3 kts Duration: 30 min Depth: up to 30 m	88 trawls/yr	Standard avoidance and move-on rule. Typically two models of pingers with different frequencies are used on each net to deter small cetaceans.

Survey Name	Survey Description	General Area of Operation	Season, Frequency, Yearly Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
					CTD profiler and rosette water sampler	Gear Type: Sea-Bird SBE 19+ CTD Deployment: Vertical drop Depth: Surface to near bottom or 200 m max	88 samples/yr	
Video Beam Trawl Collaborative Research	Survey along the continental shelf to assess the seasonal and interannual distribution of young of the year groundfishes and the potential impacts of hypoxia.	Oregon to Washington	Monthly (variable), 20 DAS Daytime operations only	University research vessels or chartered commercial fishing vessel	Bottom video beam trawl system	2 m beam trawl with digital video camera system Tow speed: 1-1.5 kts Duration: 10 min	20 - 40 deployments	Open codend on trawl, camera documents what goes in but there is no catch.
<i>Studies Using Other Gears</i>								
Aquaculture and Physiology Broodstock Collection <i>(Under the Preferred Alternative, broodstock collection efforts are incorporated into other research efforts.)</i>	Collection of fish for broodstock by various methods. Includes sablefish sampling off the Washington coast.	Washington coast	Annual, variable, monthly, 15 DAS Daytime operations only	Charter sportfishing vessel	Pelagic longline	Mainline length: 750-1000 fathoms Set Depth: 700-3000 feet (ft) Gangion length: Snap gear less than 1 ft Gangion spacing: ~10 ft apart Hook size and type: Circle hooks, barbed # of hooks and bait: 500 hooks/set, squid Soak time: ~3 hrs	30 sets/yr	Standard avoidance and move-on rule. No bait or offal discarded before or during sets. As most fishing occurs on the bottom, most risk is associated with retrieving catch.
					Hook and line gear deployed by rod and reel	Eight anglers with eight lines in the water at a time. Barbed circle hooks	6 hrs fishing per day, 90 hrs total	
					Sablefish pots	4 ft diameter pots Bait: squid, herring	1 per yr	
Near Coastal Ocean Purse Seining	Study of salmon habitat use in offshore areas of the lower estuary, near the mouth, and in nearshore areas of the ocean near the Columbia River.	Nearshore near the mouth of the Columbia River	Monthly, May- Sept, 12 DAS Daytime operations only	Chartered commercial fishing vessel	Purse seine	Net type: Purse seines Net size: 750 x 60 ft or 1000 x 40 ft Mesh size: 0.625 in (inch) (net body); 1.3 in (tow end); 0.45 in (bunt) Set duration: Generally < 1hr	75 sets/yr	The net will not be set around pinnipeds but may be set if only a few are visible in the area. Pinnipeds are often attracted to the net and easily jump into and out of the net; the net will not be opened if only pinnipeds enter it. If any dolphins or porpoises are seen within 500 m, the move-on rule is applied. If killer whales are seen at any distance, the move-on rule is applied. If any cetaceans are seen within the net it is opened immediately.
					CTD profiler	Tow speed: 0 Duration: 20-120 min	75 casts	
Newport Line Plankton Survey <i>(Under the Preferred Alternative acoustic estimates of biomass are added)</i>	Survey along the Newport Hydrographic Line to assess oceanographic conditions and zooplankton species composition and abundance	Newport Hydrographic Line, Oregon	Bi-Weekly, 26 DAS Daytime operations only	R/V <i>Elakha</i> , owned and operated by Oregon State University	Bongo net	Net type: Bongo plankton net with 335 µm mesh Net size: two 0.6 m diameter nets Tow speed: 2 kts Duration: 5-6 min Depth: 0-30 m	150 samples/yr	Standard avoidance
					Vertical plankton net	Net type: ring net with 202 µm mesh Net size: 0.5 m diameter Tow speed: 0 (vertical tow) Duration: 5-6 min Depth: Surface to near bottom or 100 m max	150 samples/yr	

Survey Name	Survey Description	General Area of Operation	Season, Frequency, Yearly Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
					CTD profiler and rosette water sampler	Gear Type: Sea-Bird SBE 19+ CTD, Deployment: Vertical drop Depth: Surface to near bottom or 200 m max	150 samples/yr	
Northern California Current Ecosystem Survey	Periodic survey of oceanographic conditions in the Northern California Current. This is opportunistic as ship time becomes available.	Off coasts of Washington and Oregon out to 200 nm	Approximately every other year, 12 DAS 24-hr operations	NOAA vessels R/V <i>Bell M. Shimada</i> and <i>Miller Freeman</i>	Vertical plankton nets	Vertical drop, variable depth	Varies with ship time	Standard Avoidance
					Bongo net	Net type: Bongo plankton net with 335 µm mesh Net size: two 0.6 m diameter nets Tow speed: 2 kts Duration: 5-6 min Depth: 0-30 m	Varies with ship time	
					CTD profiler and rosette water sampler	Gear Type: Sea-Bird SBE 19+ CTD, Deployment: Vertical drop Depth: Surface to near bottom or 200 m max	Varies with ship time	
Seafloor Mapping <i>(Under the Preferred Alternative this mapping effort would likely be in conjunction with other projects)</i>	Map seafloor along the continental margins of the U.S West Coast	California to Washington	Semi-Annually, 20 DAS every other year 24-hr operations	Chartered vessels, UNOLs vessels	Various multi-beam depth-specific echosounders	Duration: up to 24 hrs/day.	Continuous	Standard avoidance
					CTD profiler	Tow speed: 0 Duration: 20-120 min		
Southern California Groundfish Hook and Line Survey <i>(Under the Preferred Alternative this survey is expanded in geographic scope and re-named the “Coastwide Groundfish Hook and Line Survey in Untrawlable Habitat”)</i>	Hook and line survey to assess abundance of structure-associated rockfish in untrawlable areas of the southern California region. Survey sites are the same every year unless a site is unavailable due to weather or sea condition.	Southern California Bight	Annually, Sept.- Oct., 24-30 DAS Daytime operations only	Charter sportfishing vessels (2 or 3 vessels)	Hook and line gear deployed by rod and reel	Hooks: 3 anglers; 5 hooks per line; 5 sets per angler per site (75 total hooks per site) Soak time: 5 min max soak time per set Depth: 37-229 m	121 -275 sites, 20,625 hooks/yr maximum	Standard avoidance and move-on rule. No bait or offal discarded before or during sets. As most fishing occurs on the bottom, most risk is associated with retrieving catch.
					Camera sled	Tethered video camera		
					CTD profiler	Deployment: Vertical drop		
					Furuno echosounders	50 and 200 kHz; 212 dB/1µPa		
PNW Harmful Algal Bloom Survey	Survey along the Oregon and Washington coast to assess oceanographic conditions and phytoplankton species composition and abundance with an emphasis on harmful algal species. Samples collected for: Marine toxins, chlorophyll a, micro and macro nutrients, phytoplankton species ID and enumeration, DNA analysis, and dissolved oxygen.	Oregon to Washington	Summer, Fall, Annual, minimum of 10 DAS; (Ocean sampling 2 weeks - 3 months depending on ship time and which cruises we can get on) Daytime operations only	Vessels range from ocean-going research ships to small open skiffs. Size range 15-275 ft	Plankton nets	2 ft long, 20 µm mesh nets deployed by hand over the side of the vessel. Net samples only surface waters (0-2 m)	~200/cruise	Standard avoidance
					CTD profiler and rosette water sampler	Gear Type: Sea-Bird SBE 9/11+ Deployment: Vertical drop Depth: Surface to near bottom or 500 m max	~200/cruise	
Video Beam Trawl Collaborative Research	Survey along the continental shelf to assess the seasonal and interannual distribution of young of the year groundfishes and the potential impacts of hypoxia.	Oregon to Washington	Monthly (variable), 20 DAS Daytime operations only	University research vessels or chartered commercial fishing vessel	Bottom video beam trawl system	2 m beam trawl with digital video camera system Tow speed: 1-1.5 kts Duration: 10 min	20 - 40 deployments	Open codend on trawl, camera documents what goes in but there is no catch.

Survey Name	Survey Description	General Area of Operation	Season, Frequency, Yearly Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
PUGET SOUND RESEARCH AREA								
Studies Using Trawl Gear								
Beam Trawl Survey to Evaluate Effects of Hypoxia	Examined the effects of hypoxia on demersal fish in Hood Canal. A camera was mounted onto a beam trawl and the video was reviewed to measure escape response time to the bottom trawl by various bottomfish.	Five sites in southern Hood Canal and five sites in northern Hood Canal	Summer-Fall, 20 DAS Daytime operations only	R/V <i>Harold Streeter</i> (no longer in use), chartered vessels	Beam trawl with video camera, primarily with open cod end. A few tows had a closed cod-end to verify species composition identified in the video.	Net type: beam trawl Net size:2 m wide, towed along the bottom at varying depths (30, 60 and 90 m) Duration: 10 min.	One tow per site per season, 20 tows total.	Standard avoidance
					CTD profiler	Deployment: Vertical drop	20 casts	
Movement Studies of Puget Sound Species <i>(Under the Preferred Alternative the hook-and-line surveys would be increased to 20 trips/year)</i>	Various types of studies of fish movement in Puget Sound using telemetry. Involves live- capture with various gears and SCUBA divers, tagging and release of species, and placement of detection arrays. Species include sixgill shark, Chinook and Coho salmon, lingcod, ratfish, steelhead, English sole, canary rockfish, spiny dogfish, sunflower stars, and jellyfish. Operates with ESA section 10 permit for directed research on listed fish species.	Puget Sound	Year round sampling, 25 DAS Daytime operations only	A variety of small boats, such as Whalers. Charter boats used for hook-and-line, purse seines and trawls depending on the circumstances.	Bottom trawl	Net type: Commercial bottom trawls Net size: Varies Tow speed: < 3.5 kt Duration: 10 min Depth: > 10 m	12/yr	Standard avoidance and move-on rule
					Purse seines	Net type: Herring seine Net size: 1500 x 90 ft Mesh size: variable Set duration: < 1 hr Depth: < 50 m	12/yr	The net will not be set around pinnipeds but may be set if only a few are visible in the area. Pinnipeds are often attracted to the net and easily jump into and out of the net; the net will not be opened if only pinnipeds enter it.. If any dolphins or porpoises are seen within 500 m, the move-on rule is applied. If killer whales are seen at any distance, the move-on rule is applied. If any cetaceans are seen within the net it is opened immediately.
					Hook and line	Up to 12 lines in the water at once. All hooks are barbless.	10 trips per yr	Barbless hooks. No chumming. Avoid interactions with killer whales by not fishing if they are seen at any distance.
					Demersal longline	Mainline: 600 ft Depth: about 200 ft 30 hooks/set Hooks: 16/0 circle Soak time: 90 min	3 sets, 90 hooks total	Standard avoidance. Visual monitoring of area before and during the set, avoid killer whales as above.
					SCUBA divers	Divers capture jellies and stars by hand	One collection trip per site	
					VR2 passive acoustic receivers	VR2s moored on bottom with metal weights (no lines) and acoustic releases in deep water near fishing location	Continuous for season	
Puget Sound Marine Pelagic Food Web <i>(Under the Preferred Alternative the survey would be conducted only by chartered vessel and</i>	Study of the marine pelagic food web in Puget Sound focusing on the effects of land use and development of the food web.	Puget Sound	About every 5 years as funding is available, April to October, 30 DAS Daytime operations only	R/V <i>Harold Streeter</i> (no longer in use), chartered vessels	Surface trawl	Net type: Kodiak surface trawl Net size: 3.1 x 6.1 m Tow speed: 1.8-2.2 kts Duration: 10 min Depth: < 10 m	500 trawls; survey every 5 years	The low towing speeds, small net opening, and fine mesh netting make it a near certainty that we would not catch any marine mammals. Pinnipeds are often in the areas where we sample with this gear. Maintain a watch for cetaceans. If any dolphins or porpoises are seen within 500 m, the move-on rule is applied. If

Survey Name	Survey Description	General Area of Operation	Season, Frequency, Yearly Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
limited to a surface trawl)					Horizontal plankton net	Net type: 500 µm mesh plankton net Net size: 0.75 m diameter Tow speed: 2 kts Duration: 3 min Depth: 0-10 m	500 samples	
					Vertical plankton net	Net type: 250 µm mesh ring net Net size: 0.5 m diameter Deployment: Vertical tow Duration: 5-6 min Depth: Surface to near bottom or 100 m max	500 samples	
					CTD profiler and rosette water sampler	Gear Type: Sea-Bird SBE 19+ CTD Deployment: Vertical drop Depth: Surface to near bottom or 250 m max	500 samples	
Skagit Bay Juvenile Salmon Survey (Under the Preferred Alternative the survey would be conducted only by chartered vessels, limited to a surface trawl and the number of trawls would be reduced to 180)	Assesses coastal ocean conditions in Puget Sound and the growth, relative abundance, and survival of juvenile salmon during their first summer at sea.	Puget Sound	Annually, April to September, 30 DAS Daytime operations only	R/V <i>Harold Streeter</i> (no longer in use), chartered vessels	Surface trawl	Net type: Kodiak surface trawl Net size: 3.1 x 6.1 m Tow speed: 1.8-2.2 kts Duration: 10 min Depth: < 10 m	250 trawls/yr	The low towing speeds, small net opening, and fine mesh netting make it a near certainty that we would not catch any marine mammals. Pinnipeds are often in the areas where we sample with this gear. We maintain a watch for cetaceans. If any dolphins or porpoises are seen within 500 m, the move-on rule is applied. If killer whales are seen at any distance, the move-on rule is applied.
					Horizontal plankton net	Net type: 500 µm mesh plankton net Net size: 0.75 m diameter Tow speed: 2 kts Duration: 3 min Depth: 0-10 m	250 trawls/yr	
					Vertical plankton net	Net type: 250 µm mesh ring net Net size: 0.5 m diameter Deployment: Vertical tow Duration: 5-6 min. Depth: Surface to near bottom or 100 m max	250 trawls/yr	
					CTD profiler and rosette water sampler	Gear Type: Sea-Bird SBE 19+ CTD Deployment: Vertical drop Depth: Surface to near bottom or 250 m max	250 trawls/yr	
Studies Using Other Gears								
Elwha Dam Removal	Study of potential effects of dam removal on nearshore fish including ESA listed species.	Puget Sound	Monthly, 2006 to present, 20 DAS Daytime operations only	17 ft Whaler	Beach seine	Net type: Beach seine Net size: 140 x 6 ft Mesh size: < 0.25 in Duration: < 10 min	Up to 140 samples/yr	Visual monitoring of area, "move on" rule if marine mammals are within 100 m of a sampling site

Survey Name	Survey Description	General Area of Operation	Season, Frequency, Yearly Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
Groundfish Reef Surveys <i>(Not continued under the Preferred Alternative)</i>	This project was designed to measure changes in bottom fish abundance and to quantify residency of lingcod among experimental habitats placed within the survey design.	Scatchet Head at the south end of Whidbey Island	Quarterly, 2007, 2008, and 2009.	R/V <i>Minnow</i> (F2113)	SCUBA divers on line transects, artificial habitats	Artificial habitats were made out of PVC, metal frames and cinder blocks (no lines).	16 transects each survey, 4 surveys/yr, 64 transects each year	Standard avoidance
Herring Egg Mortality Survey	Explores spatial variation and drivers of herring egg loss in Puget Sound. Investigating if herring egg loss relates to vegetation types used by herring for spawning substrate, the presence of suspected large herring egg predators (diving ducks and large fish), and metrics of shoreline development.	Herring spawning locations in Puget Sound <10m deep. Includes: Squaxin Pass, Quartermaster Harbor, Elliot Bay, Port Orchard, Quilcene Bay, Holmes Harbor, Cherry Point.	February-May, 2013 and future, 20 DAS Daytime operations only	R/V <i>Minnow</i> (F2113) and R/V <i>Noctiluca</i> (F2606)	SCUBA divers, predator exclusion cages	Egg collections by hand. Cages are modified conical sablefish pots with doors sewed shut and bottom closure removed. Mesh openings ~ 3 x 3 cm. Cages deployed at first visit and retrieved on the last visit to each site (~ 10 days)	~ 600 small vegetation samples with herring eggs taken from each site per year.	Standard avoidance
<i>Heterosigma akashiwo</i> Bloom Dynamics and Toxic Effects	Identify elements of toxicity and the environmental parameters that promote growth and expression of toxicity in the raphidophyte <i>Heterosigma akashiwo</i> . Water samples collected for: marine toxins, chlorophyll a, micro and macro nutrients, phytoplankton species ID and enumeration, and DNA analysis.	Puget Sound, Georgia Strait, Strait of Juan de Fuca	Summer, Fall, 20 DAS Daytime operations only	Various	Plankton nets	20 µm mesh nets deployed by hand over the side of the vessel. Net samples only surface waters (0-2 m)	~70/yr	Standard avoidance.
					CTD profiler and rosette water sampler	Gear Type: Sea-Bird SBE 19 CTD Deployment: Vertical drop by hand Depth: Surface to near bottom or ~35 m max	~70/yr	
Lingcod Egg Collections <i>(Not continued under the Preferred Alternative)</i>	Collected lingcod eggs for hatchery work at the NWFSC Manchester's lab.	Central Puget Sound	Winter, 2010 and 2011	Small boats	SCUBA divers	Collected eggs by hand	unknown	Standard avoidance
Puget Sound Marine Diversity Studies	Beach seine sampling of fish, invertebrate, and algal assemblages to document marine biodiversity in Puget Sound and the Salish Sea	Puget Sound	Approximately monthly year round, Daytime operations only	17 ft Whaler or inflatable or other small boat, SCUBA divers	Beach seine, benthic settling plates	Net type: Beach seine Net size: 37 m long by 2.4 m wide Mesh size: 10 mm Set duration: < 10 min	Up to 100 sets/yr	Standard avoidance and move-on rule.
Puget Sound Salmon Contaminant Study	Study of contaminant concentrations in juvenile Chinook salmon from multiple sites in Puget Sound. Operates with ESA section 10 permit for directed research on listed fish species.	Puget Sound	May-July, 30 DAS Daytime operations only	17 ft Whaler	Beach seine	Net type: Beach seine Net size: 37 m long by 2.4 m wide Mesh size: 10 mm Set duration: < 10 min	Up to 100 sets/yr	Seine not deployed within 200 m of hauled out pinnipeds. Site continually monitored.
Snohomish Juvenile Salmon Studies <i>(Under Preferred Alternative the pole seine would not be used)</i>	Beach seine and fyke trap sampling of fish assemblages to document juvenile salmon use of the Snohomish estuary and pre-restoration conditions at the Qwuloolt levee breach project and adjacent reference areas. Operates with ESA section 10 permit for directed research on listed fish species.	Snohomish Estuary	Monthly year- round; twice monthly from Feb-Sept. Pole seine monthly from Oct to May.,50 DAS Daytime operations only	17 ft Whaler or inflatable	Beach seine	Net type: Beach seine Net size: 140 x 6 ft Mesh size: < 1 in Duration: < 10 min	Up to 200 sets/yr	Seine not deployed within 200 m of hauled out pinnipeds. Site continually monitored.
					Pole seine	Net type: Pole seine Net size: 40 x 6 ft Mesh size: < 1 in Duration: < 5 min	< 80 sets/yr	

Survey Name	Survey Description	General Area of Operation	Season, Frequency, Yearly Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
					Fyke trap	Net type: Barrier trap Net size: Variable Mesh size: < 0.25 in Duration: up to 6 hrs	Up to 100 sets/yr	
					CTD profiler	Deployment: Vertical drop	100 casts	
Urban Gradient Surveys	Purpose is to identify relationships between land use practices and the properties of streams and nearshore marine ecosystems around Puget Sound. Goal is to examine how ecosystem structure (the relative abundance of different species) and ecosystem functions (the processes connecting species to one another) vary according to the level of urbanization. Focus is on motile epibenthic invertebrates (e.g., shrimps, gastropods, isopods, amphipods) from eelgrass habitats.	Central Puget Sound; five pairs of study sites across a range of urbanization. (See http://www.nwfsc.noaa.gov/research/divisions/cb/ecosystem/nearshore/psug/studysites.cfm for map)	Summer, starting in 2011, 10 DAS Daytime operations only	R/V <i>Minnow</i> (F2113) or shore access	Epibenthic tow sled	1 m x 1 m mouth opening, 1 mm mesh Duration: 10 min tows in eelgrass beds at 1 m depth.	3-5 samples per site per year, 36-60 samples total	Standard avoidance
LOWER COLUMBIA RIVER RESEARCH AREA								
Studies Using Trawl Gear								
Pair Trawl Columbia River Juvenile Salmon Survey <i>(Under the Preferred Alternative, towed antennae may replace the pair trawl net for PIT detection)</i>	A surface pair trawl with a flow-through PIT tag detector is used to assess passage of tagged juvenile salmon migrating from the upper reaches of the Columbia River basin to the ocean.	Columbia River Estuary (River Kilometer 65 to 85)	March to August, 1000 hrs/yr, 80 DAS 24-hr operations	Two 41 ft utility vessels to deploy net and tow plus a small skiff to tend equipment and clear debris	Surface pair trawl (a surface trawl with two mesh wings leading to an open cod-end with a PIT detector array)	Net type: Surface trawl modified with open cod end (8 x 10 ft opening) Net size: wings 92 m x 92 m, trawl body 9 m wide x 6 m deep x 18 m long Mesh size: wings 3.8 cm, body 1.8 cm. Tow speed: 1.5 kts Duration: 8-15 hrs Depth: surface to 5 m	800 - 1200 hrs/yr	Use of deterrence devices on nuisance pinnipeds; use of a skiff and pyrotechnics (e.g. poppers and screamers) to drive animals from the trawl area and seal bombs once animals are outside of the trawl. The PIT-tag detector is at the open cod end therefore marine mammals can pass through the net and exit through the detector array if they get that far inside.
Studies Using Other Gears								
Columbia River Estuary Tidal Habitats	Study of salmon habitat use and genetic stocks of origin throughout the estuary from the river mouth to Bonneville. Operates with ESA section 10 permit for directed research on listed fish species.	Columbia River Estuary	Quarterly to monthly, 25 DAS Daytime operations only	17 ft whaler	Beach seine	Net type: Beach seine Net size: 150 x 6 ft Mesh size: < 1 in Set duration: < 10 min	< 100/yr	Samples are not taken in marine mammal areas. All sampling is on beaches and in wetlands.
					Trap nets	Net type: barrier trap Net size: variable Mesh size: < .25 in Set duration: up to 6 hrs soak time	< 50 sets/yr	
					CTD	Gear Type: Sea-Bird SBE 19+ CTD, WETstar fluorometer, C-Star transmissometer, and Sea-Bird SBE 43 dissolved oxygen sensor Deployment: Vertical drop Depth: Surface to near bottom or 200 m max.	~100/yr	

Survey Name	Survey Description	General Area of Operation	Season, Frequency, Yearly Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
					Electro-fishing	Gear types: 24-volt backpack shocker (shallow tidal fresh wetlands and floodplains); Boat electro- shocker (100 m transects, tidal-fresh channels and backwater areas)	<100 sites/yr	
					Remote PIT detection	Gear types: ≤ 6 stationery PIT antennas (up to 4 ft x 10 ft each) per tidal channel	Continuous operation, ≤ 8 sites/year	
					Fish holding pens	<0.25 in mesh, 10ft x 10 ft x 6 ft or smaller for holding fish in flooded wetlands	Episodic, <6 months/yr, 4 sites	
					Water level & temperature logger	Hobo U-model and tidbit	Continuous operations; ~12 sites/year	
					(1) Insect fall out traps, (2) emergent insect cone traps, and (3) benthic cores	(1) staked plastic tubs (50 cm x 35 cm x 14 cm) with <10% dishsoap solution; (2) plastic inverted conical traps (0.6 m²); and (3) 0.0024 m² sediment cores	monthly year round, up to 8 sites, at least 5 replicates per site	
Effects of Dredging on Crab Recruitment	Study of how Dungeness Crab respond to dredge spoils being placed in nearshore zone for beach nourishment	Nearshore Columbia River Mouth Area	Periodic, August to October, 15 DAS Daytime operations only	MERTS vessel R/V <i>Forerunner</i>	Video ROV	Benthic video sled	~ 15 days at sea	Standard avoidance
					Acoustic telemetry	Moored Vemco VR2 receivers, V9-2H transmitters	8 receivers; 30-60 tags/yr	
					"CamPod"	Video drop camera	5-6 replicate deployments	
Lower Columbia River Ecosystem Monitoring	Study of habitat occurrence and health of juvenile salmon and their prey in the Lower Columbia Estuary. Operates with ESA section 10 permit for directed research on listed fish species.	Columbia River Estuary	Monthly, February-December, 16 DAS Daytime operations only	17 ft whaler	Beach seine	Net type: Beach seine Net size: 37 m long x 2.4 m wide Mesh size: 10 mm Set duration: < 10 min	up to 200/year	Standard avoidance and move-on rule
					Plankton net	Net type: Neuston net Net size: 1m x 3 m Mesh size: 250 micrometer Set duration: 100 m/ ~ 5 min	50 /year	
Lower Columbia River Estuary Purse Seining <i>(Under Preferred Alternative, this research effort is incorporated into the “Benefits of Wetland Restoration” project)</i>	Study of salmon habitat use in the lower Columbia River estuary.	Columbia River Estuary	Bi-weekly, April to October	R/V <i>Pelican</i> and a skiff	Purse seine	Net type: Purse seine Net size: 500 x 30 ft Mesh size: 0.34 in (net body), 0.25 in (bunt) Set duration: Generally < 1 hr	90 sets/yr	Estuary sampling stations are fixed and avoid haul out areas of pinnipeds. The net will not be set around pinnipeds but may be set if only a few are visible in the area. Pinnipeds are often attracted to the net and easily jump into and out of the net; the net will not be opened if only pinnipeds enter it. If any dolphins or porpoises are seen within 500 m, the move-on rule is applied. If killer whales are seen at any distance, the move-on rule is applied. If any cetaceans are seen within the net it is opened immediately.
					CTD profiler	Gear Type: Sea-Bird SBE 19+ CTD Deployment: Vertical drop Depth: Surface to near bottom or 20 m max.	90 samples/yr	

Survey Name	Survey Description	General Area of Operation	Season, Frequency, Yearly Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
Migratory Behavior of Adult Salmon	The objective of the work is to catch fish unharmed and to tag and release them in order to determine the migratory rate of adult Chinook salmon destined for upper river spawning sites. Study conducted by cooperative research partners affiliated with commercial fisheries. Operates with ESA section 10 permit for directed research on listed fish species.	Columbia River Estuary (to Bonneville Dam)	Spring to fall, As needed to make tagging goals, 32 DAS Daytime operations only	Various commercial fishing vessels	Tangle net (designed for non-lethal capture of fish) Catch, tag, and release only.	Net type: Tangle net Net size: 600 x 40 ft Mesh size: 4.25 in Duration: 25-45 min	up to 75 sets/yr	Avoid fishing near seal and sea lion haul out areas, reduce soak times if mammals present, use of a net that marine mammals can tear (i.e., not catch themselves). Use of skiff to patrol net and deter pinnipeds through boat/human presence, use of pyrotechnics (e.g. bangers and screamers) if nuisance pinnipeds approach within 200 yards, use of seal bombs if pinnipeds approach within 20 yards but not closer than 6 ft.
Pile Dike PIT-tag Detection System	Deploy a PIT-tag detector on a pile dike to detect migrating adult and juvenile salmon.	Columbia River Estuary (near River Kilometer 70)	March to October with potential for year round 24-hr operations	Vessels are only used for servicing	Small guidance net (20 x 20 ft) anchored in place leading to an 8 x 20 ft (minimum) opening with subsurface PIT-tag detector	Net type: 18 in square mesh of bright orange twine Continuous subsurface deployment during season	Continuous operation	The size and location of the guidance net is fixed (i.e., it is not towed) and it serves to guide fish to the PIT-tag detector opening. Therefore marine mammals can pass along the wing and through the opening.

2.2.2 Mitigation Measures for Protected Species

As Table 2.2-1 indicates, NWFSC fisheries and ecosystem research is conducted in all seasons and within three primary geographic areas: the CCRA, the PSRA, and the LCRRA (see Figure 1.1-2). These research activities occur primarily within the U.S. Exclusive Economic Zone (EEZ) from California north to Southeastern Alaska, including Canadian EEZ waters. The gear types fall into several categories: trawl gear designed and deployed either at the surface, at mid-water depths, or along the bottom; purse and beach seines; tangle nets; fyke nets; longline and other hook-and-line gear; and other gears and instruments that are not designed to catch fish (various fine-meshed plankton nets, active and passive acoustic instruments, video recording equipment, Conductivity Temperature Depth (CTD) profiler, benthic settling plates, etc.).

The Status Quo Alternative is to perform fisheries and ecosystem research as it was conducted at the end of 2014, which would require authorizations for incidental take of marine mammals under the MMPA and the intentional or incidental take of protected species under the ESA. Under this alternative, the NWFSC would apply to NMFS Headquarters Office of Protected Resources (OPR) requesting regulations governing the issuance of LOAs for incidental take of marine mammals under the MMPA. The OPR would make the necessary findings, and, if appropriate, promulgate regulations and issue LOAs to the NWFSC; the LOAs would likely prescribe mitigation measures intended to reduce the risk of potentially adverse interactions with marine mammals during the specified research activities.

In addition, both OPR and the NWFSC would engage in consultations with NMFS West Coast Region (and U.S. Fish and Wildlife Service [USFWS], as appropriate) for species that are listed as threatened or endangered under the ESA. Section 7 consultations will be conducted for activities that may have incidental impacts on listed species or their habitat. These section 7 consultations, when completed, may result in the development of one or more Biological Opinions (BiOps) that state the opinions of the services as to whether or not the federal action is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. The BiOps may contain incidental take statements (ITSs) for ESA-listed species that would include reasonable and prudent measures along with implementing terms and conditions intended to minimize the impact of incidental take of ESA-listed species during NWFSC research activities.

Several NWFSC research activities included in this DPEA involve directed research on ESA-listed fish species (e.g., the Juvenile Salmon PNW Coastal Survey). These projects have operated under section 10 research permits issued by NMFS West Coast Region and will continue to apply for section 10 permits in the future. The intentional effects of the research activities on listed species has been and will continue to be assessed within the section 10 permit process and are not covered under this DPEA. The indirect or unintentional effects of that research on other resources are analyzed in this DPEA.

The Status Quo Alternative consists of the research activities described in Table 2.2-1 (see also Appendix A for an illustrated description of different gear types used and Appendix B for a summary of the spatial/temporal distribution of research efforts). The Status Quo also includes a suite of mitigation measures that were developed by the NWFSC and are currently implemented on NWFSC surveys. These mitigation measures are anticipated to be required under the MMPA and ESA processes for the specified research activities conducted by the NWFSC. However, these mitigation measures may not be sufficient to reduce the effects of NWFSC activities on marine mammals to the level of least practicable adverse impact (see Alternative 2).

The procedures described here are based on protocols used during previous NWFSC research surveys. These procedures are the same whether the survey is conducted on board a NOAA vessel or charter vessel. The NWFSC continually reviews its procedures and investigates options for incorporating new mitigation measures and equipment into its ongoing survey programs. Evaluations of new mitigation

measures include assessments of their effectiveness in reducing risk to protected species. Implementation of any such measures must also be subject to safety and practicability considerations, allow survey results to meet research objectives, and maintain consistency with previous data sets.

2.2.2.1 Vessel Strikes

When research vessels are trawling or deploying other types of sampling gear (other than acoustic equipment), vessel speeds are less than four knots, a speed at which the probability of collision with large whales and other marine mammals is negligible. When transiting between sampling stations, NWFSC research vessels cruise at 6-14 knots, but average about ten knots. This is slower than marine mammals can swim so the risk of collisions and serious injury or mortality is still very low. In addition, NWFSC research vessel captains and crew watch for marine mammals while underway during daylight hours and take necessary actions to avoid them. There are currently no Marine Mammal Observers (MMOs) aboard the vessels dedicated to watching for marine mammals to minimize the risk of collisions, although the large NOAA vessels operated by the NOAA Corps (e.g., R/V *Bell M. Shimada*) include one bridge crew dedicated to watching for obstacles at all times, including marine mammals. When research vessels are operating in areas and times when many marine mammals have been seen, additional crew may be brought up to the bridge to monitor for whales and captains may also reduce speed to improve the chances of observing whales and avoiding them. At any time during a survey or in transit, any bridge personnel that sights protected species that may intersect with the vessel course immediately communicates their presence to the helm for appropriate course alteration or speed reduction as possible to avoid incidental collisions, particularly with large whales.

2.2.2.2 Mitigation Measures for Protected Species during Research with Trawl Gear

The following protocols apply to all NWFSC surveys and research projects using surface trawl gear (Nordic 264 Trawl), mid-water trawl gear (Modified Cobb Midwater Trawl, Aleutian Wing Midwater Trawl, and commercial trawl gear), and bottom trawl gear (commercial-sized bottom trawls, double rigged shrimp trawl, Poly Nor'easter bottom trawl, modified Aberdeen bottom trawl, and 2-meter beam trawl). However, the great majority of marine mammals taken in NWFSC research gear in the past have been caught in surface trawl gear. While these mitigation measures have been in place for all trawl surveys since 2009, surveys using surface trawl gear have implemented monitoring and avoidance of marine mammal practices for many years prior to 2009 and have a strong culture of marine mammal mitigation as part of their survey operations. Where differences between implementation of these measures exist between surface trawl surveys and all other trawl surveys, they are noted below. These measures are relevant to all protected species, including sea turtles, but in actual practice they involve primarily marine mammals because sea turtles are rarely seen during NWFSC surveys and have never been caught in NWFSC research gear. Note that the NWFSC conducts joint cruises with the SWFSC (i.e., the joint hake-sardine integrated acoustics-trawl survey). During joint surveys, the mitigation measures related to gear deployment for sardine sampling (conducted at night) are the responsibility of the SWFSC scientific team under SWFSC protected species protocols, and the mitigation measures related to gear deployment for hake (generally conducted during the day) are the responsibility of the NWFSC scientific team using the protected species protocols described below.

1. Monitoring methods

- The vessel captain and bridge crew monitor for protected species during transit and, on surface trawl surveys, are joined by designated members of the scientific party assigned to watch for marine mammals as part of the pre-set protocols as the vessel approaches a station. Detection of protected species is by visual observation with the aid of bridge binoculars as necessary. In general, average effective observation distance is about 500 meters from the vessel. A number of

factors influence the ability of observers to detect protected species, including, but not limited to; the species, size, and numbers of animals present, their distance from the vessel and behavior, lighting conditions, weather conditions, sea state, and the specific vessel being used.

- For any trawl operations that are conducted at night (regardless of survey type), mitigation methods using visual observations will be ineffectual and unreliable because potential detection distances of marine mammals are small and typically limited to the area immediately surrounding the vessel. Thus, in situations when night sampling occurs, we do not apply these mitigation protocols that rely on visual observation. When conditions make it useful, the captain and several of the science crew will watch for marine mammals. Sea state and cloud cover will have a significant effect on effectiveness of observations. The best viewing conditions occur with a full moon, winds of <5 mph and wave heights of only several feet. Night operations are conducted consistently using the Modified Cobb trawl in the CCRA for juvenile rockfish and occasionally using the Nordic 264 net (for limited special studies). Deck lights are used when crew are working on deck but only illuminate the immediate area around the vessel.
- For surface trawl surveys, the period of marine mammal monitoring begins about 10 minutes before the vessel is on station and extends continuously until the net has been retrieved. When crew are assigned to monitor for marine mammals, they are dedicated to that task (i.e., they do not have any other duties while monitoring). As the vessel approaches the station, the captain and at least one assigned science crew monitor for marine mammals. Within several minutes of arriving on station and finishing their sampling duties, two additional science crew are assigned to monitor for marine mammals. From this point throughout the tow there are at least three assigned science crew and the vessel captain watching for marine mammals. However, depending on the numbers of marine mammals that have been seen during the station approach or are expected at that particular place and season, additional science and vessel crew may be assigned to stand watch in different locations around the ship, with the goal of providing 360 degree monitoring coverage around the vessel. The number of crew available to monitor depends on the completion of other duties, the willingness of off-duty personnel to assist, and the need to avoid observer fatigue.
- For mid-water and bottom trawl surveys, the Chief Scientist must confirm with the captain or the bridge that no marine mammals or other protected species have been seen within 500 meters of the ship or appear to be approaching the ship during a 10-minute period prior to the deployment of any trawl gear. The 10-minute observation period is conducted by the captain and bridge crew and typically occurs during transit prior to arrival at the sampling station, but may also include time on station if other types of gear or equipment (e.g., bongo nets) are deployed before the trawl.
- During standard trawl operations, at least some of the trackline to be towed is typically traversed prior to setting gear in order to check for hazards along the transect or, in the case of bottom trawls, to scan the bottom with echosounders to see if it is trawlable. On surface trawl surveys, CTD casts and plankton/bongo net hauls are made prior to setting the trawl. These activities can take 25-35 minutes after the vessel arrives on station, depending on water depth, and monitoring for marine mammals continues throughout these activities. Mid-water trawls and bottom trawls may not deploy other gears before deploying their trawl gear but reconnaissance of the trawl line often takes 10-15 minutes after arriving on station. In addition, once the decision is made to deploy the trawl gear, monitoring continues while the net is unspooled, which may take about 10 minutes. Before the trawl doors are deployed, the net floats on the surface behind the vessel but it is closed and actions can be taken if marine mammals are sighted near the ship (see operational procedures below). Thus, the monitoring period for marine mammals begins before the vessel

arrives on station and extends continuously through gear deployment, typically for over 30 minutes on all trawl types.

- For surface trawls, monitoring for marine mammals continues after the trawl doors are deployed with a minimum of three and up to eight observers, including the bridge crew and assigned members of the science party. Care is taken to provide some rest periods for observers to avoid observer fatigue. Lookouts divide up the area around the boat to ensure at least one person is looking at each sector around the vessel. At least two pairs of binoculars are on board and available for observers to verify a potential sighting. Lookouts search for any surface sign of marine mammal (e.g. blow, splash, dorsal fin) between the times when the trawl mouth is first deployed in the water until the time the trawl mouth is recovered on deck. Lookouts immediately alert the captain and Chief Scientist as to their best estimate of the following information, relative to the ship's position, about any marine mammal or suspected marine mammal:
 - Distance
 - Bearing
 - Type/species
 - Number of individuals
 - Direction of travel or behavior
- For surface trawls, monitoring all around the ship continues until the trawl retrieval begins, at which point the focus is on the stern and the trawl itself. For mid-water and bottom trawls, once the trawl doors are deployed the net sinks to the intended depth and continued monitoring of animals at the surface would not be helpful in assessing marine mammal activity at the depth of the net. There have been no NWFSC historical interactions of marine mammals when using bottom trawls and only one interaction when using the Modified Cobb mid-water trawl. The risk of interactions with these gears once the trawl doors are deployed appears to be low and monitoring efforts are reduced to the bridge crew while scientific crew attend to other duties.
- In the case of surveys conducted aboard smaller research or chartered fishing vessels, the number of individuals and the amount of their time that may be devoted to serving as protected species lookouts may be limited. Under these circumstances more reliance may be placed on the captain and/or Chief Scientist to maintain a watch.

2. Operational procedures

- NWFSC fisheries research is conducted either on NOAA vessels operated by professional captains and crew from the NOAA Office of Marine and Aviation Operation (OMAO) or on chartered vessels with their own professional vessel captains and crew. The captain of the vessel has the final authority for all decisions regarding operations of the ship. The Chief Scientist has responsibility for the science mission and works collaboratively with the captain and crew to accomplish that mission. Decisions about when and where to deploy or retrieve research gear, or not deploy or retrieve gear, are made by the Chief Scientist or other designated science crew for various reasons (including the presence of marine mammals, as described below). However, the captain (or officer on watch) must consider the safety of the vessel and crew and has final authority on whether or not to carry out the decisions of the science crew.
- “Move-On” Rule. If any marine mammals are sighted within 500 meters of the vessel and are considered at risk of interacting with the vessel or research gear, or appear to be approaching the vessel and are considered at risk of interactions, the vessel has several options depending on the

circumstances of the sighting. First, the set can be delayed while the vessel remains on site for some time period, usually at least 10 minutes, to see if they move off. If the marine mammals move off, the monitoring crew will conduct another 10-minute watch after the animals leave and, if no additional sightings are made, the trawl gear may be deployed. Second, the vessel may be moved away from the animals to a different section of the sampling area if the animals appear to be at risk of interaction with the gear. After the vessel is moved, monitoring protocols continue as reconnaissance of the new location is conducted and any other scientific gear is deployed (CTDs, bongos, etc.), a period of at least 10 minutes since moving to the new location. If no marine mammals are sighted that are considered at risk of interacting with the vessel or research gear, the trawl gear may be deployed.

- Marine mammals that are sighted further than 500 meters from the vessel are monitored to determine their position and movement in relation to the vessel. If they appear to be closing on the vessel, the move-on rule protocols may be implemented even if they are initially further than 500 meters from the vessel.
- After moving on, if marine mammals are still visible from the vessel and appear to be at risk, the officer on watch, in consultation with the Chief Scientist, may decide to move again or to skip the station.
- The officer on watch will consult with the Chief Scientist or other designated scientist (identified prior to the voyage and noted on the cruise plan) and other experienced crew as necessary to determine the best strategy to avoid potential takes of marine mammals. Strategies are based on the species encountered, their numbers and behavior, their position and vector relative to the vessel, and other factors. For instance, a whale transiting through the area and heading away from the vessel may not require any move, may require a short delay before the gear is set, or may require only a short move from the initial sampling site, while a pod of dolphins gathered around the vessel may require a longer move from the initial sampling site or possibly cancellation of the station if the dolphins follow the vessel. Trawl gear is not deployed if marine mammals have been sighted within 500 meters of the ship unless those animals do not appear to be in danger of interactions with the trawl, as determined by the judgment of the Chief Scientist and officer on watch.
- During trawl operations, the most appropriate response to avoid incidental take is determined by the professional judgment of the officer on watch, in consultation with the Chief Scientist or other designated scientist and other experienced ship's crew and science crew as necessary. In general, the critical distance for deciding to retrieve the net early is an observation of a marine mammal within 500 meters of the ship or marine mammals sighted at a greater distance but clearly closing on the vessel. These judgments take into consideration the species, numbers, and behavior of the animals, type of net being used, the status of the trawl net operation (net opening, depth, and distance from the stern), the time it would take to retrieve the net, and safety considerations for changing speed or course. Because the surface trawl is more prone to capturing marine mammals, based on the historical experience of the NWFSC, decisions on what course of action to follow may be different than for a mid-water or bottom trawl. In some situations, such as whale sightings, the risk of adverse interactions may be diminished by continuing to trawl until the marine mammals have left the area before beginning haul-back operations. In other situations, swift retrieval of the net may be the best course of action. If the Chief Scientist is not on watch during a trawl, any member of the scientific party has the authority to recommend to the officer on watch to halt trawling operations if a marine mammal is observed in the vicinity and considered to be at risk. The Chief Scientist does not have to be notified before action is taken.

- All monitoring periods are documented in a logbook or on data sheets. Pertinent information includes: 1) Confirmation that the marine mammal monitoring protocol was completed prior to deployment of gear, 2) Records of any stations dropped because of the presence of marine mammals, and 3) Species or types of marine mammals observed (if possible) within 500 meters of the ship that cause an adjustment in our set protocols (e.g., extending of observation period).
- Logbooks from surface trawling operations indicate that, from 2008 through 2012, the NWFSC shortened 9.2% of tows and had to skip (not set at all) 0.9% of surface tows (out of a possible 694 tows). For comparison, 4 tows (0.6%) of the 694 conducted caught marine mammals. Shortened or skipped tows may also occur due to masses of jellyfish or gear complications but most of these incidents were because of the presence of marine mammals. The logbook data do not include the numbers of delays or moves caused by the presence of marine mammals but the move-on rule is implemented on a regular basis, especially during May and June when migratory marine mammals are in the area.
- Care is taken when emptying the trawl, including opening the cod end as close as possible to the deck of the checker (or sorting table) in order to avoid damage to protected species that may be caught in the gear but are not visible upon retrieval. The gear is emptied as quickly as possible after retrieval in order to determine whether or not protected species are present.

3. Tow duration

- Standard tow durations are typically 30 minutes or less at the targeted depth, excluding deployment and retrieval time, to reduce the likelihood of attracting and incidentally taking protected species. Note that retrieval and deployment times can exceed trawling time, depending on the gear. These tow durations decrease the opportunity for curious marine mammals to find the vessel and investigate. The resulting tow distances are typically 1 to 2 nautical miles, depending on the survey and trawl speed. Additionally, although the NWFSC has never caught sea turtles in trawl gear, short tow times reduce the likelihood that incidentally captured sea turtles would drown.

4. Acoustic pinger devices

- For surface trawls only (using the Nordic 264 trawl), two pairs of acoustic signaling devices known as “pingers” are installed near the net opening, one on either side. Acoustic pingers, when submerged, emit an underwater pulse of sound, or “ping”. The intent of these devices is to discourage marine mammals from entering the net (see Appendix A).
- Pingers are manufactured by a number of companies but two brands typically used by the NWFSC include the Aquatec Subsea Limited, model AQUAmark, and Fumunda Marine, models F10 and F70. Pingers remain operational at depths between 10 m and 200 m. Tones range from 200 to 400 microseconds in duration, repeated every 5 or 6 seconds, with variable frequency of 10-160 kHz. The pingers generate a maximum sound pressure level of 145 decibels (dB) root mean square referenced to 1 micropascal at one meter.

2.2.2.3 Mitigation Measures for Protected Species during Research with Purse Seine Gear

- Several projects use either commercial herring seines (1500 feet x 90 feet) or research seines (500 feet x 30 feet) (see Appendix A). The crew keep watch for marine mammals before and during a set. If a bird or marine mammal observer is on board, the observer(s) inform the Chief Scientist and captain of any marine mammals detected at or near a sampling station. Observations focus on

avoidance of cetaceans (e.g., killer whales, dolphins, and porpoises) and aggregations of pinnipeds.

- Small numbers of pinnipeds are often attracted to fish caught in the purse seine and frequently jump into the net, catch a fish, and jump back out of the net without getting entangled. The net will not be opened if only pinnipeds enter it. If pinnipeds are in the immediate area where the net is to be set, the set is delayed until the animals move out of the area or the station is abandoned. However, if small numbers of pinnipeds (generally less than five) are seen in the vicinity but do not appear to be in the direct way of the setting operation, the net may be set. The decision to set the net even if a few pinnipeds are visible is an attempt to balance the risk of capturing pinnipeds and the need to complete the research when small numbers of pinnipeds are present, which occurs frequently.
- If any dolphins or porpoises are observed within about 500 meters of the vessel, the net will not be set until the animals move further away. If any dolphins or porpoises are observed in the net, the net will be immediately opened to let the animals go.
- If killer whales are seen at any distance, the net will not be set and the move-on rule is applied. Note that other whales are very rare in Puget Sound but sightings would elicit the same response as killer whales.

2.2.2.4 Mitigation Measures for Protected Species during Research with Beach Seine Gear

- Beach seines are typically set inshore by small boat crews that visually survey the area for marine mammals prior to set. Sets are not made within 200 meters of any hauled out pinnipeds.
- Seines are deployed with one end held on shore by a crew member and the net slowly deployed by boat in an arc and then retrieved by pulling both ends onto shore. Typical seine hauls are less than 15 minutes with the resultant catch sampled and released. Marine mammals are unlikely to interact with the net as they would typically not remain on the shore or in the water in the presence of the field crew. If marine mammals are observed to be interacting with the gear, it is lifted and removed from the water.

2.2.2.5 Mitigation Measures for Protected Species during Research with Puget Sound Surface (Kodiak) Tow Net

- This gear type is a small (10 feet x 20 feet) net towed at slow speeds (about 2 knots) as close to shore as the net can be fished. It is only used in Puget Sound. The slow speed and small size of the net make it nearly impossible to catch a marine mammal because the mammals can easily outswim the net or swim out of the net if they encounter it. Because pinnipeds are common in Puget Sound and are often nearby on shore (within 50 meters) when the net is being fished, it is not possible to use a move-on rule for pinniped observations at any reasonable distance and still conduct the work. If only pinnipeds are observed in the area, net deployment and retrieval proceeds as specified by the research design. However, if any cetaceans are observed near a site (within about 500 meters) or appear to be approaching a site from farther out, then the site is either abandoned or the vessel holds to determine the behavior of the marine mammals (i.e., whether they are moving through or not) and then either begins fishing or moves on.

2.2.2.6 Mitigation Measures for Protected Species during Research with Pair Trawl Gear

- The pair trawl is operated in the Columbia River estuary at one location. The net is open (there is no bag or cod end) and it is held open in the same spot and not towed. Potentially, a marine mammal could become entangled in the net and material that holds the nets open. Mitigation for

this sampling method includes having research personnel constantly monitoring this equipment and using deterrents (pyrotechnic “poppers” and “screamers” to drive sea lions or seals [pinnipeds] from the trawl area and active “seal bomb” deterrence once outside of the trawl) to dissuade pinnipeds from the equipment. Pinnipeds attempting to catch fish inside research gear are considered “nuisance animals” and the humane, non-lethal removal of such animals by government employees (i.e., NWFSC researchers) acting in the course of official duties is exempted under Section 109(h) of the MMPA (16 USC 1379). An occasional pinniped swimming near the trawl is tolerated but occasionally a persistent animal appears. A deckhand then approaches the pinniped in the tender skiff, which often is sufficient to dissuade the animal by itself. If the pinniped continues to approach the net and is within the trawl wings, poppers or screamers are fired from a pistol near the animal. When the animal leaves the trawl, a follow-up with a seal bomb is attempted from the chase skiff to further discourage interactions with the trawl system. An average of 26 seal bombs have been used in recent years to drive pinnipeds away from the net, all in late April and May when sea lions are most abundant in the area.

2.2.2.7 Mitigation Measures for Protected Species during Research with Tangle Net Gear

- The tangle net is similar to a gill net in that it is designed to catch salmon by ensnaring them but there is a major difference in that the tangle net is designed to ensnare fish by their teeth rather than their gills so as not to harm them (see Appendix A). Fish that are caught are tagged with either a PIT tag or a PIT tag and an acoustic transmitter, measured, fin-clipped and released. The following mitigation measures are implemented to minimize interactions with marine mammals.
- Avoidance is the first and foremost measure taken to mitigate encounters with marine mammals. Sampling locations are rotated daily to avoid pinnipeds. If pinniped presence near the sampling nets cannot be controlled, sampling is discontinued for the day at that location.
- Pinnipeds attempting to catch fish from research gear are considered “nuisance animals” and the humane, non-lethal removal of such animals by government employees (i.e., NWFSC researchers) acting in the course of official duties is exempted under Section 109(h) of the MMPA (16 USC 1379). NMFS is in the process of developing guidelines for appropriate devices and methods to deter nuisance animals and the NWFSC will comply with the new guidance when it becomes available.
- Each sampling boat is accompanied by a skiff whose primary purpose is to patrol the net to visually deter pinnipeds through boat/human presence.
- Pyrotechnics (e.g. poppers and screamers) are used to deter pinnipeds if they approach within distances of approximately 200 yards but no closer than 70 yards. Use of these aerial devices is most effective at turning pinnipeds away and keeping them away from the sampling area if they are present in the area. In recent years, acoustic deterrents have been used 15-20 days each year (25 days maximum). The maximum number of deterrents used per day is approximately 50. Use of pyrotechnics is authorized within the sampling area by the Oregon Department of State Police Office of State Fire Marshal, through permit #A136-2011. The NWFSC will continue to comply with any laws or regulations concerning the discharge of pyrotechnics in their research areas.
- Seal bombs are used to deter predators that have approached within 20 yards of the net but are no closer than 6 feet. Seal bombs explode beneath the surface of the water and create a loud noise between the net and the pinnipeds. Their typical response is to move off several yards, but this rarely causes them to leave the area entirely. Therefore this method of deterrence is primarily used to keep pinnipeds away from the net long enough to collect the gear, remove fish from the gear, or move to another sampling location.

- The net is constructed of lightweight material which is designed to snare the fish without harming them but has an incidental benefit that it would break easily if marine mammals are caught.
- The sampling nets are typically deployed for short periods of time (25 to 45 minutes) at each location.

2.2.2.8 Mitigation Measures for Protected Species during Research with Longline Gear

- The NWFSC only uses longline gear on a limited basis to collect specimens for aquaculture research and tagging studies. Longline efforts are conducted aboard smaller vessels and with fewer crew members than trawl surveys but the monitoring procedures for longline gear are similar to those described for trawling gear. The officer on watch, Chief Scientist (or other designated member of the scientific party), and crew standing watch visually scan, usually with binoculars, for marine mammals, sea turtles, and other protected species during all longline operations. The member of the crew designated to stand watch for protected species is dedicated to that function and visually scans the waters surrounding the vessel at least 30 minutes prior to the planned start of setting the gear into the water. Protected species monitoring would typically be performed from the wheelhouse or bridge of the vessel. However, the specific location on the vessel and the elevation above sea level from which the surveillance is conducted may be adapted to suit the size and design of the particular vessel.
- Before the gear is deployed, the “move-on” rule is implemented if any protected species are present near the vessel and appear to be at risk of interactions with the longline gear; longline sets are not made if marine mammals or sea turtles have been seen from the vessel within the past 30 minutes and appear to be at risk of interaction with the longline gear, as determined by the professional judgment of the Chief Scientist or officer on watch. If setting operations have been halted due to the presence of the protected species, setting does not resume until no protected species have been observed for at least 30 minutes.
- Once longline gear is in the water, monitoring for protected species will continue. If any are detected, the Chief Scientist or officer on watch will determine the most appropriate course of action to minimize risk of interactions based on the species, number, and behavior of the protected species in the area as well as the status of the ship and gear, weather and sea conditions, and crew safety factors. If appropriate, haul-back of the gear may be postponed until the officer on watch determines that it is safe to proceed.
- The use of circle hooks reduces the risk of adverse sea turtle interactions. The NWFSC has never caught sea turtles on longline gear.
- NWFSC longline protocols specifically prohibit chumming (i.e., releasing additional bait to attract target species to the gear). Bait is removed from hooks during retrieval and retained on the vessel until all gear is removed from the area. The crew does not discard offal or spent bait while longline gear is in the water to reduce the risk of marine mammals detecting the vessel or being attracted to the area.

2.2.2.9 Mitigation Measures for Protected Species during Research with Other Hook-and-line Gear

- Hook-and-line operations are used to sample groundfish in untrawlable habitats, collect species for aquaculture operations (e.g., sablefish), and to collect salmon and other species for acoustic tagging along the California, Oregon, and Washington coasts and in Puget Sound. These projects are conducted on smaller vessels and with fewer crew members than trawl surveys but the

monitoring procedures for hook-and-line gear are the same as those described for longline gear. Some research projects employ contracted commercial trolling vessels deploying commercial hook-and-line gear (with barbless hooks) to conduct non-retention sampling.

- Marine mammals can be attracted to fish caught on hook-and-line gear and face potential injury from hooks as they depredate the lines. A swallowed hook or hook that remains attached to an animal (e.g., in its mouth) could cause injury. Hooks used to catch salmon present a lower risk of injury because they are barbless. Barbed hooks used to collect other species have a higher risk of injury. Protocols prohibit chumming or throwing anything overboard that might attract marine mammals during sample fishing.
- Because pinnipeds are common in Puget Sound and are often nearby on shore (within 50 meters) when the hook-and-line gear is being fished, it is not possible to use a move-on rule for pinniped observations at any reasonable distance and still conduct the work. If only pinnipeds are observed in the area, hook-and-line gear deployment proceeds as specified by the research design. However, if any cetaceans are observed near a site (within about 500 meters) and are considered to be at risk of interaction with the gear, or appear to be approaching the vessel from farther out and are considered to be at risk of interaction with the gear, then the site is either abandoned or the vessel holds to determine the behavior of the marine mammals (i.e., whether they are moving through or not) and then either begins fishing or moves on.

2.2.2.10 Plankton Nets, Oceanographic Sampling Devices, Video Cameras, SCUBA Divers, and Remotely Operated Vessel (ROV) Deployments

- The NWFSC deploys SCUBA divers and a wide variety of gear to sample the marine environment during their research cruises, such as plankton nets, oceanographic sampling devices (e.g., CTD rosettes), video cameras, and ROVs. These types of research activities are not considered to pose any risk of adverse gear interactions with protected species and are therefore not subject to specific mitigation measures. However, the officer on watch and crew monitor for any unusual circumstances that may arise at a sampling site and use their professional judgment and discretion to avoid any potential risks to protected species during deployment of all research equipment. In the case of SCUBA divers, researchers attempt to avoid pinnipeds hauled out on buoys or piers by dropping divers up-current from the target and keeping the support vessel away from the pinnipeds. However, pinnipeds may leave their haulouts to investigate the divers underwater. These types of disturbances are considered in section 4.2.4 of this DPEA.

2.2.2.11 Handling Procedures for Incidentally Captured Protected Species

Marine Mammals

- Captured live or injured marine mammals are released from research gear and returned to the water as soon as possible with no gear or as little gear remaining on the animal as possible (this is typically the responsibility of the fishing crew, not the scientific crew). Animals are released without removing them from the water if possible. Data collection is conducted in such a manner as not to delay release of the animal(s) or endanger the crew and includes as much information as possible on species, age, sex (if genital region is visible), location, description of the event, disposition at release (e.g., live, dead, hooked, entangled, amount of gear remaining on the animal, etc.), and photographs. At no time does the scientific crew attempt to acquire biological samples from an incidentally captured marine mammal, as the intent is to return the animal to its habitat as quickly and safely as possible. Immediately following an incidental capture, a set of pre-determined contacts are made to determine the course of action for the remainder of the survey.

- In general, incidental captures are reported as soon as possible to the on-land Principal Investigator (PI) and recorded in the logbook. If the PI is unavailable, then one of the following individuals in the following order is contacted: Program Manager, Deputy Division Director, Division Coordinator, or Division Director. The NWFSC Environmental Compliance coordinator (currently this is Kurt Fresh with Fish Ecology Division) is contacted as soon as possible regardless of which program or division is responsible for the take as this person (or designee) is responsible for entering the information into the NMFS National Protected Species Incidental Take Data Base (PSIT) within 24 hours. The intent of this contact is to provide information for the attached incident report to be filed (time and location of incidental take, what was taken, and associated circumstances that can explain conditions leading to the take). The PI or other initial on-land contact has the responsibility to contact the Regional Administrator of the NMFS West Coast Region and provide the report as specified in the two-page NWFSC “Report of Take” form (Appendix D). The West Coast Regional Administrator or representative must respond within 12 hours to the on-land PI and Chief Scientist at sea and provide clear instructions (both verbally to the Chief Scientist and by email or FAXed memo to the ship, if email/FAX is available on board) as to whether or not research operations are allowed to continue. Information on species age, sex, location and description of the event, including degree of injury, if known, should be reported to NOAA Headquarters within 24 hours. This notification occurs as a result of entering the take (within 24 hours) in the PSIT data base.
- Occasionally, a decaying marine mammal carcass has been retrieved during trawling operations. These incidents should be documented, photographed (if practical), returned to the sea, and reported to the PI at the completion of the cruise.
- If a large whale is alive and entangled in fishing gear, the vessel should immediately call the U.S. Coast Guard (USCG) at VHF Ch. 16 and/or the appropriate Marine Mammal Health and Stranding Response Network for instructions. Entangled whales may be reported to the NOAA Fisheries entanglement reporting hotline (1-877-767-9425).

Fish

- Handling procedures for fish will only focus on incidental take of listed species. Protocols are in place to process and handle directed take of listed species as part of Section 10 permits. There are a number of listed species that could be caught by NWFSC gears. Some of these can be challenging to differentiate, even for experts.
- If a sturgeon is brought aboard as an incidental take, first identify the fish to species if possible (green sturgeon are ESA-listed while white sturgeon are not) and determine if is alive or dead. If dead, record data using the data sheet in Appendix D. Take photographs of the specimen from several angles. Freeze the entire specimen if possible. If the specimen cannot be frozen, take a fin clip off the dorsal fin or tail (size of a dime) and preserve in alcohol. If the specimen is alive, record fork length, take photographs, and release the fish as quickly as possible.
- Incidentally caught salmon can range in size from several inches to over a meter and include six different species. Given that most incidental takes of salmonids will be with gear that are not effective for catching salmon, numbers should be low. In general, juvenile and subadults will be dead or severely injured after being caught in a trawl. Conversely, most salmonids caught on hook and line should be alive. Fish identification sheets are provided to all surveys along with a measuring board and vials for fin clips. Some populations of Chinook, coho, sockeye, and steelhead are ESA-listed. We assume that incidental take of salmonids will be low (< 5 per haul) and thus the following guidelines are appropriate. The following are handling and data recording procedures for salmonids:

**2.2 Alternative 1 – No-Action/Status Quo Alternative –
Conduct Federal Fisheries and Ecosystem Research with Scope and Protocols Similar to Past Effort**

- Adults of any species (>450 mm tail fork length) – Identify the specimen, measure fork length, record if adipose is missing, take a fin clip (dorsal or caudal) and put in labeled vial, and release as quickly as possible.
 - Juveniles and sub adults (<450 mm tail fork length) – Assuming there is a freezer or some sort of cold storage available, identify the specimen, kill it humanely, and put in individually labelled bag. If the specimen cannot be retained, identify the specimen, record capture information, measure fork length, take fin clip, and release.
- In Puget Sound, several species of rockfish are ESA-listed - Boccaccio, yelloweye rockfish, and canary rockfish. Because these fish typically live at considerable depths, they are likely to be dead or seriously injured when brought onto the boat. Thus, we recommend that unless the fish is clearly alive, that the fish be killed and then frozen whole with a label (see Appendix D for data to be recorded).
- The southern population segment of eulachon are ESA-listed as threatened. Therefore, any eulachon caught incidentally should be assumed to be listed. While small catches of eulachon are possible, it is also possible that a trawl surveys may catch 100's to 1000's of individual in hauls. If logistically possible (e.g., there is freezer space), small catches of eulachon (<20) should be frozen whole in a labeled bag. In the event of a large catch (>20) and freezing fish is possible, put 20 individual eulachon into a labeled bag and freeze. Either count and release the rest of the fish or estimate total numbers using some subsampling procedure and then release the fish. If preserving specimens is not possible, then count or estimate numbers in the haul, record fork length of up to 20 eulachon in a haul and release them.

2.3 ALTERNATIVE 2 – PREFERRED ALTERNATIVE - CONDUCT FEDERAL FISHERIES AND ECOSYSTEM RESEARCH (NEW SUITE OF RESEARCH) WITH MITIGATION FOR MMPA AND ESA COMPLIANCE**2.3.1 NWFSC Research Activities under the Preferred Alternative**

The Preferred Alternative is comprised of a combination of research activities continued or modified from the past and additional, new research surveys and projects. Several surveys and projects described in Table 2.2-1 under the Status Quo Alternative will not be continued under the Preferred Alternative. Those research activities have been noted in Table 2.2-1 and include the following:

- PNW Ichthyoplankton Survey
- PNW Piscine Predator and Forage Fish Survey
- Aquaculture and Physiology Broodstock Collection
- Groundfish Reef Survey
- Lingcod Egg Collections

Several new research surveys and projects have been added to the Preferred Alternative that were not included in the Status Quo Alternative and other existing research projects have been modified; these new projects and changes in existing projects are summarized in Table 2.3-1. The Preferred Alternative therefore includes all of the continuing research programs described in Table 2.2-1 plus the additions/changes described in Table 2.3-1.

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Table 2.3-1 Summary Description of Additional NWFSC Surveys and Research Projects Conducted on NOAA Vessels and NOAA-chartered Vessels under the Preferred Alternative

See Appendix A for descriptions of the different gear types and vessels used. Appendix B includes figures showing the spatial/temporal distribution of fishing gears used during NWFSC research. Mitigation measures are described in Section 2.2.1 and 2.3.1. Abbreviations used in the table: CTD = Conductivity Temperature Depth; DAS = days at sea; cm2 = square centimeter; freq = frequency; ft = feet; hrs = hours; in = inch; kHz = kilohertz; km = kilometer; kts = knots; L = liter; m = meter; m3 = cubic meter; max = maximum; MHz = megahertz; mi = miles; min = minutes; mm = millimeter; NA = Not Available or Not Applicable; nm = nautical miles; TBD = to be determined; v = volt; yr = year; ~ = approximately.

Survey Name	Survey Description	General Area of Operation	Season, Frequency, Yearly Days at Sea	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
CALIFORNIA CURRENT RESEARCH AREA								
Studies Using Trawl Gear								
Flatfish Broodstock Collection	Collection of fish for broodstock for aquaculture development by trawls, hook-and-line, and various methods.	Puget Sound and Washington coast	Intermittent, up to 20 times annually, 20 DAS Daytime operations only	Charter fishing vessel, NOAA small boats	Bottom trawl	Net type: Commercial bottom trawl Net size: Varies Tow speed: < 3.5 kts Duration: 10 min Depth: > 10 m	6-24 trawls	Standard avoidance and move-on rule.
					Hook and line	Up to 12 lines in the water at once. Barbed circle hooks	18 annually	
Groundfish Bottom Trawl Survey <i>(Adds net camera to Status Quo protocols)</i>	Fisheries independent survey to monitor groundfish distribution and biomass along the U.S. West Coast at depths of 55 to 1280 m.	U.S./Mexico to U.S./Canada border	Annually, May to October, at least 190 DAS Daytime operations only	Charter, four commercial trawlers	Bottom trawl Active acoustics CTD profiler	As described in Table 2.2-1 with addition of video camera to bottom trawl net	As described in Table 2.2-1	Standard avoidance and move-on rule.
Juvenile Salmon PNW Coastal Survey <i>(Adds marine mammal excluder device on Nordic 264 trawl net and removes use of Simrad EK60 echosounder compared to Status Quo protocols)</i>	Assesses Pacific Northwest Coastal ocean condition and the growth, relative abundance, and survival of juvenile salmon during their first summer at sea.	Newport, OR to Cape Flattery, WA in Continental shelf waters	May, June, and September, Annually, 36 DAS (roughly divided equally between May, June and Sept) Daytime operations only	Charter commercial fishing vessel	Surface trawl	Net type: Nordic 264 surface trawl with marine mammal excluder device Net size: 30 m wide x 20 m deep Tow speed: 3-4 kts Duration: 30 min Depth: surface down to 30 m 4 acoustic pingers attached to the net	180 trawls/yr	Standard avoidance and move-on rule. Marine mammal excluder device consists of a rigid grate and escape hatch (orientation and deployment details still under development). Typically two models of pingers with different frequencies are used on each net to deter small cetaceans.
					CTD, plankton nets, and water pump	As described in Table 2.2-1	As described in Table 2.2-1	
Marine Fish Broodstock Collection, Sampling, and Tagging	Collection of fish for broodstock collection, sampling, tagging.	Washington coast	Annual, varied timing, 10 DAS Daytime operations only	Charter fishing vessel	Bottom trawl	Net type: Commercial bottom trawls Net size: Varies Tow speed: 1.5-3.5 kts Duration: up to 4 hrs Depth: 50-1000 m	10 trawls/yr	Standard avoidance and move-on rule.
					Pelagic longline	Mainline length: 750-1000 fathoms Depth: 700-3000 ft Gangion length: Snap gear less than 1 ft Gangion spacing: ~10 ft apart Hook size and type: Circle hooks, barbed # of hooks and bait: 500 hooks/set; squid Soak time: ~3 hrs	30 sets/yr	Standard avoidance and move-on rule. No bait or offal discarded before or during sets.

2.3 Alternative 2 – Preferred Alternative - Conduct Federal Fisheries and Ecosystem Research (New Suite of Research) with Mitigation for MMPA and ESA Compliance

Survey Name	Survey Description	General Area of Operation	Season, Frequency, Yearly Days at Sea	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
					Hook and line gear deployed by rod and reel	Eight anglers with eight lines in the water at a time. Barbed circle hooks	6 hrs fishing per day, 90 hrs total.	
Studies Using Other Gears								
Coastwide Groundfish Hook and Line Survey in Untrawable Habitat <i>(Expanded effort compared to Status Quo for the Southern California Groundfish Hook and Line Survey)</i>	Hook and line survey to monitor groundfish distribution and abundance along the U.S. West Coast expanded coastwide and nearshore	U.S.-Canada to U.S.-Mexico border	Annually, May - Oct., 250 DAS Daytime operations only	Charter sportfishing vessels (3 to 4 vessels)	Hook and line gear deployed by rod and reel	Hooks: 3 anglers; 5 hooks per line; 5 sets per angler per site (75 total hooks per site) Soak time: 5 min soak time per set Depth: 15-250 m	1000 sites, 75,000 hooks total	Standard avoidance and move-on rule. No bait or offal discarded before or during sets. Gear lightweight and unlikely to entangle marine mammals
					Camera sled and drop cameras	Tethered video camera	1000 deployments	
					CTD profiler	Deployment: Vertical drop	1000 casts	
Newport Line Plankton Survey <i>(Adds active acoustics to Status Quo protocols)</i>	Survey along the Newport Hydrographic Line to assess oceanographic conditions and zooplankton species composition and abundance	Newport Hydrographic Line, Oregon	Bi-Weekly	R/V Elakha, owned and operated by Oregon State University; NOAA vessel if available	Bongo net Vertical plankton net CTD profiler and rosette water sampler	As described in Table 2.2-1	175 samples each	Standard avoidance
					Multi-frequency active acoustics	38, 70, 120, and 200 kHz (Simrad EK60)	Continuous during cruise	
Technology Development Research	Develop alternative sampling methodologies using autonomous underwater vehicles to assess groundfish abundance and distribution using video capturing equipment.	Washington to California and Western Pacific	Summer and Fall, up to 20 DAS Daytime operations only	Chartered vessels, UNOLs vessels, NOAA vessels (R/V Bell M. Shimada)	Autonomous underwater vehicle and associated equipment	AUV (Autonomous Underwater Vehicle), one of which is called Lucille. It is not tethered and is piloted remotely. It is several meters long. Dives have been up to 2000 ft deep. It is used with multiple objectives.	No sampling other than video. Number of dives varies by scientific objective; up to 17 dives per cruise.	Standard Avoidance
PUGET SOUND RESEARCH AREA								
Studies Using Trawl Gear								
Marine Fish Collections Including Flatfish	Collection of marine fish for research including broodstock.	Puget Sound	Annual, varies, monthly, 15 DAS 24-hr operations	Charter vessel	Bottom trawl	Net type: Commercial bottom trawls Net size: Varies Tow speed: 1.5-3.5 kts Duration: up to 4 hrs Depth: 50-1000 m	40 bottom trawls/yr	Standard avoidance and move-on rule.
Movement Studies of Puget Sound Species <i>(Hook and line effort increased compared to Status Quo protocols)</i>	Various types of studies of fish movement in Puget Sound using telemetry. Involves capture and tagging of species and placement of detection arrays. Species include sixgill shark, Chinook and Coho salmon, lingcod, ratfish, steelhead, English sole.	Puget Sound	Year round sampling	A variety of small boats, such as Whalers. Charter boats used for hook-and-line, purse seines and trawls depending on the circumstances.	Bottom trawls, purse seines, demersal longlines, SCUBA divers, VR2 passive acoustic receivers	As described in Table 2.2-1	As described in Table 2.2-1	Standard avoidance and move-on rule. Other elements as described in Table 2.2-1
					Hook and line	Up to 12 lines in the water at once. All hooks are barbless.	20 trips/yr (increased from 10 trips/yr)	Barbless hooks. No chumming. Avoid interactions with killer whales by not fishing when killer whales are less than 500 m away.

2.3 Alternative 2 – Preferred Alternative - Conduct Federal Fisheries and Ecosystem Research (New Suite of Research) with Mitigation for MMPA and ESA Compliance

Survey Name	Survey Description	General Area of Operation	Season, Frequency, Yearly Days at Sea	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
Puget Sound Marine Pelagic Food Web <i>(Reduced effort compared to Status Quo protocols)</i>	Study of the marine pelagic food web in Puget Sound focusing on the effects of land use and development of the food web.	Puget Sound	Annually, April to October, 30 DAS Daytime operations only	Chartered vessels	Surface trawl only (Eliminate plankton nets, CTD, and water samples)	Net type: Kodiak surface trawl Net size: 3.1 x 6.1 m Tow speed: 1.8-2.2 kts Duration: 10 min Depth: < 10 m	250 trawls/yr (decreased from 500 trawls/yr)	The low towing speeds make it a near certainty that we would not catch any marine mammals. Pinnipeds are often in the areas where we sample with this gear. Maintain a watch for listed marine mammals (killer whales) and cetaceans. If any cetaceans are within about 500 m of a station, we either let them clear or move on.
Skagit Bay Juvenile Salmon Survey <i>(Reduced effort compared to Status Quo protocols)</i>	Assesses coastal ocean conditions in Puget Sound and the growth, relative abundance, and survival of juvenile salmon during their first summer at sea.	Puget Sound	Annually, April to September, 30 DAS Daytime operations only	Chartered vessels	Surface trawl only (Eliminate plankton nets, CTD, and water samples)	Net type: Kodiak surface trawl Net size: 3.1 x 6.1 m Tow speed: 1.8-2.2 kts Duration: 10 min Depth: < 10 m	180 trawls/yr (decreased from 250 trawls/yr)	The low towing speeds make it a near certainty that we would not catch any marine mammals. Pinnipeds are often in the areas where we sample with this gear. Maintain a watch for listed marine mammals (killer whales) and cetaceans. If any cetaceans are within about 500 m of a station, we either let them clear or move on.
Studies Using Other Gears								
ESA-listed Rockfish Genetics	This project collects fin clips from all bottomfish captured during hook-and-line fishing with a focus on locating and getting genetic samples from ESA-listed rockfish species (yelloweye, canary, and bocaccio rockfish). These are not standardized surveys to quantify abundance or density estimates, but are being used to collect size, weight, location, depth, and genetic information from bottom fish species. The intent is to release all fish unharmed. Operates with ESA section 10 permit for directed research on listed fish species.	Puget Sound, San Juan Islands and the Strait of Juan de Fuca	Spring, summer, and fall, 35-41 DAS Daytime operations only	Charter boats: <i>F/Vs Joker, Venture, Dash One, All Star, Morning Star, Fishfull Thinking II, Malia Kai, Cabazon, Darla Orion, Ann Patrice</i>	Hook and line fishing gear - bait and jigs	Hook and line fishing with bait (herring and squid) or bottom jigs such as darts. Average 4 hooks per day for 18.2 hook-hours per day.	Approximately 750 hook-hours per year with target numbers of fishes in each area.	Standard avoidance and move-on rule. Capture and processing of ESA-listed fish is authorized under an ESA section 10 directed research permit.
Long-term Eelgrass Monitoring	We will begin long-term monitoring of fringe eelgrass habitats in Puget Sound in 2015. This work will be used to quantify growth, pressures, and community structure of eelgrass beds over the next 20 years to monitor for potential changes due to climatic/oceanic conditions and management actions related to shoreline armoring and land-use practices.	Sites will be within Puget Sound proper and will be paired across a range of urbanization gradients.	Quarterly beginning in 2015, 10 DAS Daytime operations only	<i>R/V Minnow</i> (F2113)	SCUBA divers, sediment grabs, and water samples in niskin bottles	Transects will be used to quantify fish, invertebrate, and eelgrass densities. Collection of seagrass, sediments, and water samples will be used to quantify epiphyte loads and sediment quality, and water chemistry.	4 transects per site (~5 sites) each quarter = 360 transects per year	Standard avoidance

2.3 Alternative 2 – Preferred Alternative - Conduct Federal Fisheries and Ecosystem Research (New Suite of Research) with Mitigation for MMPA and ESA Compliance

Survey Name	Survey Description	General Area of Operation	Season, Frequency, Yearly Days at Sea	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
Marine Fish Research Including Broodstock Collection, Sampling, and Tagging	Collection of fish for broodstock, sampling, and tagging.	Puget Sound	Annually, timing varies monthly, 15 DAS Daytime operations only	Charter sportfishing vessel	Pelagic longline	Mainline length: 750-1000 fathoms Depth: 700-3000 ft Gangion length: Snap gear less than 1 ft Gangion spacing: ~10 ft apart Hook size and type: Barbed circle hooks Number of hooks and bait: 500 hooks/set; squid Soak time: ~3 hrs	30 sets/yr	Standard avoidance and move-on rule. No bait or offal discarded before or during sets.
					Hook and line gear deployed by rod and reel	Eight anglers with eight lines in the water at a time, barbed circle hooks	6 hrs fishing per day, 90 hrs total	
Snohomish Juvenile Salmon Studies <i>(Reduced effort compared to Status Quo protocols)</i>	Beach seine and fyke trap sampling of fish assemblages to document juvenile salmon use of the Snohomish estuary and pre-restoration conditions at the Qwuloolt levee breach project and adjacent reference areas.	Snohomish Estuary	Monthly year-round; twice monthly from Feb-Sept., 50 DAS Daytime operations only	17 ft Whaler	Beach seine Fyke trap (Eliminate pole seine)	As described in Table 2.2-1	As described in Table 2.2-1	All sites continually staffed and monitored, seine removed if marine mammals are present.
LOWER COLUMBIA RIVER RESEARCH AREA								
Studies Using Trawl Gear								
Eulachon Arrival Timing	Determine the arrival timing and distribution of spawning eulachon at the mouth of the Columbia river. Samples will be taken for fecundity and other biological data but most fish will be released unharmed.	Columbia River Estuary and Plume	January to March (about 6 times), 15 DAS Daytime operations only	NOAA R/Vs <i>Magister</i> and <i>Murrelet</i>	Midwater trawl	Net type: Modified Cobb trawl with 9.5 mm codend Net size: 12 x12 m opening Tow speed: 2.7 kts Duration: 15 min Depth: 30-40 m	60 trawls/yr	Standard avoidance and move-on rule.
Studies Using Other Gears								
Benefits of Wetland Restoration to Juvenile Salmon: Action Effectiveness Monitoring	Study of salmon habitat use in the lower Columbia River estuary focusing on determining benefits that juvenile salmon obtain from restoring wetland habitats. Operates with ESA section 10 permit for directed research on listed fish species.	Columbia River Estuary, Bonneville Dam to mouth	Bi-weekly, March to October, 32 fishing days Daytime operations only	R/V <i>Pelican</i> and a skiff	Purse seine	Net type: Purse seine Net size: 500 x 30 ft Mesh size: 0.34 in (net body), 0.25 in (bunt) Set duration: Generally < 1 hr	90 sets/yr	Estuary sampling stations are fixed and avoid haul out areas of pinnipeds. The net will not be set around pinnipeds but may be set if only a few are visible in the area. Pinnipeds are often attracted to the net and easily jump into and out of the net; the net will not be opened if only pinnipeds enter it. If any dolphins or porpoises are seen within 500 m, the move-on rule is applied. If killer whales are seen at any distance, the move-on rule is applied. If any cetaceans are seen within the net it is opened immediately.
					CTD profiler	Gear Type: Sea-Bird SBE 19+ CTD Deployment: Vertical drop Depth: Surface to near bottom or 20 m max.	90 samples/yr	
			Quarterly, March to December. Daytime	17 ft Whaler	Beach seine	Net type: beach seine Net size: 150 x 6 ft Mesh size: < 1 in Set duration: < 10 min	Two sites per day. Two to three hauls per site. 16 sampling days per year.	

2.3 Alternative 2 – Preferred Alternative - Conduct Federal Fisheries and Ecosystem Research (New Suite of Research) with Mitigation for MMPA and ESA Compliance

Survey Name	Survey Description	General Area of Operation	Season, Frequency, Yearly Days at Sea	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
			operations only	17 ft Whaler	Trap nets	Net type: barrier trap Net size: variable Mesh size: < .25 in Set duration: up to 6 hrs soak time	Two sites per day. Two to three hauls per site. 16 sampling days per year.	
				Two small boats, 17 ft Whaler sized boat plus larger tow boat.	Small surface trawl	Net type: surface trawl Net size: 10 x 20 ft Mesh size: 1.0 in (net body), 0.5 inch bag Set duration: Generally 15 minutes	Two sites per day. Two to three hauls per site. 16 sampling days per year.	

2.3.2 Mitigation Measures for Protected Species

Under the Preferred Alternative, the NWFSC would apply for authorizations under the MMPA and the ESA for incidental take of protected species while conducting the suite of research activities described above. This process requires regulations and authorizations for incidental take of marine mammals under the MMPA and incidental take of protected species under the ESA. Under this alternative, the NWFSC is applying to NMFS Headquarters Office of Protected Resources (OPR) requesting regulations governing the issuance of LOAs for incidental take of marine mammals under the MMPA. The OPR will make the necessary findings and, if appropriate, will promulgate regulations and issue LOAs to the NWFSC. The LOAs would prescribe mitigation measures intended to reduce the risk of potentially adverse interactions with marine mammals during the specified research activities.

In addition, both OPR and the NWFSC will engage in ESA section 7 consultations with NMFS West Coast Regional Office (and U.S. Fish and Wildlife Service [USFWS]) for species that are listed as threatened or endangered. These consultations may result in the development of a Biological Opinion (BiOp) that determines whether or not the federal action is likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of any critical habitat. The BiOp could contain an incidental take statement (ITS) for ESA-listed species that includes reasonable and prudent measures along with implementing terms and conditions intended to minimize the impact of incidental take of ESA-listed species during NWFSC research activities.

Under the Preferred Alternative, the NWFSC would also continue to apply for section 10 directed research permits for the intentional take of ESA-listed species and Scientific Research Permits (SRPs) for research that will affect MSA species managed under FMPs.

The Preferred Alternative includes the same suite of mitigation measures described in the Status Quo Alternative to reduce the risk of adverse interactions with protected species. In addition, there are several gear modifications that the NWFSC is proposing to implement under the Preferred Alternative that would mitigate or help monitor interactions with protected species, particularly marine mammals.

- The NWFSC is currently testing a marine mammal excluder device (MMED) that will be incorporated into the Nordic 264 surface trawl net used for the Juvenile Salmon PNW Coastal Survey. This device is a rigid grate with a set of bars across the cod end of the net and an escape hatch just forward of this set of bars (Appendix A). This device was originally developed by the Southwest FSC for use in its sardine survey (Dotson et al. 2010). The NWFSC has tested the net/excluder device design used by the Southwest FSC and found that it caused a significant loss of salmon species that were the target of their research (report in prep.). More recent experiments have used video cameras attached to the net opening and near the excluder device to test different configurations of the excluder device to minimize loss of target species. The experiments have looked at adding weight and stiffeners to the flap covering the escape hatch to keep it closed and flipping the MMED so the escape hatch faces down rather than up. Based on preliminary results, this downward-pointing escape hatch appears to be the best design for minimizing loss of target species. Additional research will be necessary to calibrate catch levels in tows with the excluder device compared to past tows that did not contain the excluder (i.e., to align the new catchability rates with historical data sets). During these configuration and calibration experiments some nets will be fished without the MMED in order to provide controls for catchability. Once the NWFSC completes these experiments the MMED will be used in all future trawls with this net. The NWFSC will use high-resolution video cameras on tows made with and without the MMED both to evaluate effects of the MMED on catch and to determine if marine mammals enter the net

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undetected by observers and either escape on their own by swimming out of the net or through the MMED. All video data will be digitally recorded and reviewed at a later date.

- For the Pair Trawl Columbia River Juvenile Salmon Survey, experimental development of large (8 feet x 20 feet) flexible antenna housings for PIT-tag detection was begun in 2013. The NWFSC is testing the potential to replace the pair trawl net with a matrix of such large coiled antennas towed at high speed. There would be virtually no potential for marine mammal interactions with such a mobile, flexible PIT-tag detection system and no need to use various deterrence techniques for nuisance pinnipeds, such as skiff sentinels, pyrotechnics, or seal bombs. The NWFSC will implement a switch to the new flexible antenna system if it becomes practicable.
- The Groundfish Bottom Trawl Survey will add video cameras to the trawl net during calibration and experimental tows for the purpose of identifying fish and studying fish behavior as they enter the net. While this change in protocol is intended to facilitate fisheries research, it could provide incidental information about potential interactions with marine mammals, if they enter the net. No marine mammals have been caught in NWFSC bottom trawls to date.

The NWFSC considers the current suite of monitoring and operational procedures to be necessary and sufficient to minimize adverse interactions with protected species and still allow the NWFSC to fulfill their scientific mission. However, many of the mitigation measures described in the Status Quo Alternative could also be considered “best practices” for safe seamanship and avoidance of hazards during fishing. Most, if not all, NWFSC researchers are aware of the explicit links between the implementation of these best practices and their usefulness as mitigation measures for avoidance of protected species. However, the specific conditions for implementing these mitigation measures in all situations have not been formalized or widely discussed among all scientific parties and vessel operators. The NWFSC therefore proposes a series of improvements to its protected species training, awareness, and reporting procedures under the Preferred Alternative. The NWFSC expects these new procedures will facilitate and improve the implementation of the mitigation measures described under the Status Quo Alternative. The enhanced mitigation measures included in the Preferred Alternative are anticipated to be sufficient for and required by NMFS under MMPA and ESA authorizations for the specified research activities affiliated with the NWFSC.

- Under the Preferred Alternative, the NWFSC will initiate a process for its Chief Scientists and vessel captains to communicate with each other about their experiences with protected species interactions during research work with the goal of improving decision-making regarding avoidance of adverse interactions. As noted in the Status Quo Alternative description of mitigation measures, there are many situations where professional judgment is used to decide the best course of action for avoiding protected species interactions before and during the time research gear is in the water. The intent of this mitigation measure would be to draw on the collective experience of people who have been making those decisions, provide a forum for the exchange of information about what went right and what went wrong, and try to determine if there are any rules-of-thumb or key factors to consider that would help in future decisions regarding avoidance practices. The NWFSC would coordinate not only among its staff and vessel captains but also with those from other fisheries science centers with similar experience.
- Another new element of the Preferred Alternative is the proposed development of a formalized protected species training program for both new and experienced crew members that would be required for all NWFSC-affiliated research projects, including cooperative research partners that are funded through the NWFSC (see Section 1.1.5). Because of the three diverse ecosystems the NWFSC conducts its research in, training or workshops would be tailored for staff working in each ecosystem. Training programs would be conducted on a regular basis and would include

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topics such as monitoring and sighting protocols, species identification, decision-making factors for avoiding take, procedures for handling and documenting protected species caught in research gear, and reporting requirements. The NWFSC will work with the Northwest Fisheries Observer Program (NWFOP) to develop a customized protected species training program and materials appropriate for NWFSC fisheries research activities. The NWFOP currently provides protected species training (and other types of training) for NMFS-certified observers placed on board commercial fishing vessels. All NWFSC research crew members that may be assigned to monitor for the presence of protected species during future surveys will be required to attend an initial training course and refresher courses annually or as necessary. The implementation of this training program would formalize and standardize the information provided to all crew that might experience protected species interactions during research activities.

- For all NWFSC-affiliated research projects and vessels, written cruise instructions and protocols for avoiding adverse interactions with protected species will be reviewed and, if found insufficient, made fully consistent with any training materials and guidance on decision-making that arises out of the two training opportunities described above. In addition, informational placards and reporting procedures will be reviewed and updated as necessary for consistency and accuracy. Many research cruises already include pre-sail review of protected species protocols for affected crew but the NWFSC will emphasize the need for such pre-sail briefings and require them to be included before all research cruises, including those conducted by cooperating partners.
- The NWFSC will incorporate specific language into its contracts that specifies all training requirements, operating procedures, and reporting requirements for protected species that will be required for all charter vessels and cooperating partners.

2.3.3 Handling Procedures for Protected Species

Another difference between the Status Quo and the Preferred Alternative involves handling and data collection procedures for incidentally captured marine mammals. Certain types of data are needed to evaluate the severity of marine mammal injuries, which has implications for marine mammal stock assessments and classification of takes for MMPA and ESA compliance purposes. The Chief Scientist and other designated scientists will receive training on the types of information needed to make injury determinations through the protected species training program described above. If the safety of the crew and captured animal will not be compromised, the scientific party or trained crew will attempt to collect biological information from captured, live marine mammals before they are released, including species identification, sex identification (if genital region is visible), estimated length, and photographs. This information will be recorded on standardized regional commercial fishery observer forms. If the safety of the crew or the captured animal would be compromised by this data collection effort, the animal will be immediately released. In addition to gathering data on incidentally caught animals, the Chief Scientist or trained crew would be required to remove as much gear as possible from an animal before release. Gear remaining on an animal has the potential to cause future entanglements and generally increases the chances that an injury will be serious. Human safety is paramount when considering whether and how to disentangle or dehook a marine mammal.

The Chief Scientist will submit data on all captured animals to marine mammal experts at the appropriate NMFS Science Center who will use specific criteria to determine whether the injury is considered serious (i.e., more likely than not to result in mortality). If insufficient data has been collected for any reason, the marine mammal experts may not be able to determine the severity of the injury. However, the marine mammal experts may use other types of information to assign the injury to either the serious or non-serious categories.

2.3 Alternative 2 – Preferred Alternative - Conduct Federal Fisheries and Ecosystem Research (New Suite of Research) with Mitigation for MMPA and ESA Compliance

2.3.4 Unknown Future NWFSC Research Activities

In addition to the activities identified above, the NWFSC may propose additional surveys or research activities within the timeframe covered by this programmatic analysis. Because of the annual cycle under which decisions to fund and/or conduct research are made, the NWFSC cannot identify in advance all the potential future activities that may take place over the next five years. For purposes of this programmatic analysis, NMFS has examined the research activities that have occurred through 2014 and used this information as a proxy for future proposed research activities. Taken together, these activities comprise the actions evaluated within this DPEA under the Preferred Alternative.

In the future, as congressional appropriations and NMFS fisheries research budgets are established, the NWFSC will examine the proposed future research to determine if the activities are consistent with the scope of actions considered under the Preferred Alternative. To be considered ‘within scope’ under this DPEA, future proposals for specific research projects must be consistent with the gear types, spatial/temporal distribution of research activities, and types of effects analyzed within this document. If future research projects are not consistent with the type or scope of fisheries research activities analyzed in this DPEA, they will be subject to additional NEPA, ESA, and MMPA evaluations.

More specifically, the basic methodology used to evaluate any proposed future research activity will be as follows:

1. **Evaluate the activity to determine if it would be conducted within the geographic scope of the region evaluated in the DPEA.** The evaluation described in Chapter 4 of this DPEA is based on the historic spatial distribution of research surveys. Any future research activities proposed within the geographic areas described in Chapter 4 would pass this step of the evaluation. Any proposed research outside of those areas may require additional evaluation.
2. **Evaluate the seasonal distribution of the activity.** The activities evaluated in this DPEA are conducted throughout the year but certain surveys are only conducted in specific time frames/seasons. If a program was proposed that was similar in methodology to past surveys but significantly shifted the timing of research activities from what was analyzed in this DPEA, additional evaluation would be required.
3. **Evaluate the gear types proposed.** The gear types that were included in the analysis are described in Appendix A. If the proposed future research activity used the same or very similar gear in the same manner analyzed in this DPEA, then the research activity would fall within the analysis conducted. The research activity would not have to exactly match the descriptions in this DPEA, because the same impacts would be expected from similar gear types and activities. For example, if a new side-scan sonar were to be deployed, but the signal strength and frequency were within the ranges evaluated for bottom sounding sonar evaluated in this DPEA, then the impacts would be similar because only the area swept by the sonar would be changing. If a new type of gear was to be deployed, or if a gear type was to be used in substantially different ways than described, environmental impacts not considered in this DPEA could result and additional NEPA analysis may be required.
4. **Evaluate the status of the resources that may be affected by the research.** The DPEA uses an average level of catch and bycatch as well as the frequency and nature of past interactions with various protected species to determine the impacts of research on marine resources. The DPEA considers the effects of past research on living marine resources based on their current or recent status in regards to population level or conservation concern. However, the status of those resources, e.g., fish stocks, varies over time and by fishery management region. If a future project proposes to conduct research on a fish or invertebrate stock that is overfished or depleted at the time, or if it would occur in areas and with gear that would likely result in substantial bycatch of

overfished stocks, the potential effects of the proposed research project could be much greater than estimated in the DPEA and additional NEPA analysis would be required.

To reiterate, any proposed action 1) conducted in regional areas described in this DPEA, 2) during times of the year considered, 3) using gear types and methods generally equivalent to the methods evaluated, and 4) being directed at fish or invertebrate stocks that would not be affected substantially by the research, would be considered covered by the conclusions drawn in this DPEA. If future proposed research activities, projects, or programs are not consistent with the type or scope of fisheries research activities analyzed in this DPEA, they would be subject to additional NEPA evaluations.

2.4 ALTERNATIVE 3 – MODIFIED RESEARCH ALTERNATIVE - CONDUCT FEDERAL FISHERIES AND ECOSYSTEM RESEARCH (NEW SUITE OF RESEARCH) WITH ADDITIONAL MITIGATION

Under Alternative 3, the NWFSC would continue fisheries research as described in Section 2.3 and Appendix A with authorizations for incidental take and directed research under the MMPA and the ESA for all protected species. Alternative 3 would include all of the same mitigation measures required by the MMPA and ESA authorization procedures as described for the Preferred Alternative. The difference between Alternative 3 and the Preferred Alternative is that Alternative 3 includes a number of additional mitigation measures derived from a variety of sources including: (1) comments submitted from the public on similar fisheries actions, (2) discussions within NMFS as a part of the proposed rulemaking process, and (3) a literature review of past and current research into potential mitigation measures. The new suite of research activities is a combination of past research and additional, new research, as described for the preferred alternative.

The NWFSC regularly reviews its procedures and investigates options for incorporating new mitigation measures and equipment into its ongoing survey programs. Evaluating new mitigation measures includes assessing their effectiveness in reducing risk to protected species, but measures must also: pass safety and practicability considerations, meet survey objectives, allow survey results to remain consistent with previous data sets, and be consistent with the purpose and need for NWFSC research activities (Section 1.3). Some of the mitigation measures considered in this alternative (e.g., no night fishing or broad spatial/temporal restrictions) would essentially prevent the NWFSC from collecting data required to provide for fisheries management purposes under the MSA. Some research surveys necessarily target fish species that are preyed upon by marine mammals with an inherent risk of interactions with marine mammals during these surveys. The NWFSC acknowledges the inherent risk of these surveys (e.g., the juvenile salmon survey and juvenile rockfish survey), and it has implemented a variety of measures to mitigate that risk. The NWFSC currently has no viable alternatives to collecting the data derived from these surveys and does not propose to implement potential mitigation measures that would preclude continuation of these surveys, such as the elimination of night surveys or use of pelagic trawl gear. An analysis of the potential efficacy and practicability of the additional mitigation measures considered in this alternative is presented in Section 4.4.

The secondary federal action covered under this DPEA is the issuance of requested regulations and subsequent Letters of Authorization under Section 101(a)(5)(A) of the MMPA that would govern the unintentional taking of small numbers of marine mammals incidental to the NWFSC's research activities. In order to authorize incidental take of marine mammals under the MMPA, NMFS must identify and evaluate a reasonable range of mitigation measures that may reduce adverse impacts to marine mammals to the level of "least practicable adverse impact." As described above, some mitigation measures could prevent the NWFSC from maintaining the utility of ongoing scientific research efforts, and those mitigation measures would normally be excluded from consideration in the DPEA under screening criteria 3 (Section 2.1). However, such mitigation measures would likely be considered during the MMPA incidental take authorization process and/or ESA Section 7 consultation and are therefore considered under Alternative 3 in this DPEA.

2.4.1 Additional Mitigation Measures for Protected Species**2.4.1.1 Monitoring methods**

Visual observations (using bridge binoculars as needed) by the officer on watch, Chief Scientist or other designated scientist, and crew standing watch are currently the primary means of detecting protected species in order to avoid potentially adverse interactions. However, there are other detection methods that

2.4 Alternative 3 – Modified Research Alternative - Conduct Federal Fisheries and Ecosystem Research (New Suite of Research) with Additional Mitigation

have been used in commercial fisheries, naval exercises, and geotechnical exploration that could be considered. These additional types of detection methods would be intended to be used in specific circumstances, such as operating at night or in low visibility conditions.

- Visual surveillance by dedicated protected species observers. This measure would require the NWFSC to use trained protected species observers whose dedicated job is to detect the presence of marine mammals and other protected species within the survey area and communicate their presence to ship operations personnel. This dedicated observer position would be different than having marine mammal and/or bird biologists on board whose job is to conduct abundance and distribution surveys (as is currently the practice on some NWFSC surveys). Considerations include the use of dedicated observers for all surveys or during research surveys of particular concern.
- Use of a camera or underwater video system to monitor any interactions of protected species with all trawl gear (in addition to the Nordic 264 surface trawl). Underwater video technology may allow the NWFSC to determine the frequency of interactions with research gear and to evaluate the effectiveness of a measure's ability to mitigate injurious or lethal interactions.
- Use of passive acoustic monitoring for marine mammal vocalizations to aid in the detection of marine mammals present in the survey area and to implement appropriate modifications of research operations.
- Use of aircraft, unmanned aerial vehicles, or autonomous underwater gliders to provide additional detection capabilities.
- Use of infrared (IR) technologies to detect protected species.
- Use of night-vision devices to detect protected species.

2.4.1.2 Operational restrictions

- This measure would require the NWFSC to suspend trawl operations at night or during periods of low visibility (including fog and high sea state) to minimize interactions with protected species that would be difficult to detect by visual monitoring.
- Video sampling with an open cod end: The NWFSC would investigate the use of video cameras to identify fish and their encounter rates in lieu of a closed cod end on trawl surveys, which may take protected species as well as target fish. This approach could be appropriate for swept area surveys designed to determine the density of fish or verification of acoustic target identification. However, it would not be appropriate for surveys designed to determine the condition of fish or the growth rates of fish as these measurements require the handling or dissection of specimens. It may also be impractical for surveys of juvenile fish that require microscopic analysis to identify species. Considerable insight and experience may be gained by experimenting with open cod end trawls and associated high-resolution, high-speed video cameras, particularly with real-time video feeds to the ship. In some cases this experience could lead to routine use of cameras instead of capture. In other situations the number of closed cod end trawls required for estimating vital rates could be reduced. While it would not be the primary objective, video camera data may also provide documentation of protected species interactions with trawl gear and may thus provide insight into the efficacy of other measures intended to reduce the interactions with protected species (e.g., excluder devices).

2.4 Alternative 3 – Modified Research Alternative - Conduct Federal Fisheries and Ecosystem Research (New Suite of Research) with Additional Mitigation

- Decoy vessels for longline projects. This measure would require use of a decoy research vessel playing prerecorded longline fishing sounds to distract marine mammals away from the fishing grounds.
- Streamer lines for longline projects. Under this measure, the NWFSC would deploy streamer lines before longline gear is set to mitigate the risk of catching seabirds. Deploying streamer lines on each side of the baited longline to discourage seabirds from diving on baited hooks has been proven effective in reducing seabird bycatch in some Pacific fisheries (Melvin et al. 2001) and have recently been proposed as a seabird bycatch reduction measure for the Pacific Coast Groundfish Fishery for vessels 55 feet length overall or greater (79 FR 53401).

2.4.1.3 Acoustic and visual deterrents

- This measure would require the NWFSC to use deterrents, such as acoustic pingers or recordings of predator vocalizations (e.g., killer whale) to deter interactions with research gear, or use visual deterrence techniques (e.g., lights, light sticks, reflective twine/rope) to reduce marine mammal interactions with the gear.

2.4.1.4 Marine mammal and sea turtle excluder devices

- This measure would require the NWFSC to use marine mammal and/or turtle excluder devices on all of its trawl nets (in addition to the Nordic 264 surface trawl) or on a subset of those gears considered to have a high risk of protected species interactions.

2.4.1.5 Temporal or geographic restrictions

- Spatial/temporal restrictions are one of the most direct means of reducing adverse impacts to protected species. By reducing the overlap in time and space of the survey's footprint with known concentrations of protected species, the NWFSC may reduce the amount of incidental take of such species. This measure would require the NWFSC to identify areas and times that are most likely to result in adverse interactions with protected species (e.g., areas of peak abundance) and to avoid, postpone, or limit their research activity to minimize the risk of such interactions with protected species as long as such spatial/temporal restrictions do not conflict with the ability of the NWFSC to conduct scientifically valid surveys and to provide the best scientific information available for purposes of managing commercial fisheries. This may include limits on specific locations, physical or oceanographic features, biologically important times, and/or gear types.
- Avoidance of federal and state marine protected areas. This measure would disallow or restrict NWFSC trawl surveys in federal and/or state marine protected areas (Section 3.1.2).

2.5 ALTERNATIVE 4 – NO RESEARCH ALTERNATIVE - NO FIELD RESEARCH CONDUCTED OR FUNDED BY NWFSC

Under the No Research Alternative the NWFSC would no longer conduct or fund fieldwork for the fisheries and ecosystem research considered in the scope of this DPEA in marine waters of the Pacific, Columbia River Estuary, or Puget Sound. This moratorium on fieldwork would not extend to research that is not in scope of this DPEA, such as directed research on marine mammals and ESA-listed species covered under separate research permits and NEPA documents. NMFS would need to rely on other data sources, such as fishery-dependent data (e.g., harvest data) and state or privately supported fishery-independent data collection surveys or programs to fulfill its responsibility to manage, conserve and protect living marine resources in the U.S. Under this alternative, organizations that have participated in joint research programs may or may not continue their research efforts depending on whether they are able to secure alternative sources of funding. Any non-federal fisheries research would occur without NMFS funding, direct control of program design, or operational oversight. It is unlikely that these non-NMFS fisheries research surveys would be consistent with the time series data NMFS has collected over many years, which is the core information supporting NMFS science and management missions and vital to fishery management decisions made by the Fishery Management Councils, NMFS, and other marine resource management institutions, leading to greater uncertainty for fishery and other natural resource management decisions.

Currently, fisheries and marine ecological research is also being conducted by the U.S. Navy, National Science Foundation, tribal governments, state agencies, other international agencies, and research institutes in the three NWFSC research areas, sometimes with funding support from the NWFSC. However, much of the fisheries related research conducted by non-NMFS entities is generally confined to state waters and near-shore ocean areas and does not cover many fisheries topics currently investigated by the NWFSC. Under the No Research Alternative, it is unlikely that any of the state or other institutional research programs would be able to undergo the fundamental realignment of budgets and scientific programs necessary to maintain the level and continuity of information currently provided by the NWFSC. No agencies or other entities would likely conduct marine research to replace the research abandoned by the NWFSC in the three research areas under the No Research Alternative.

2.6 ALTERNATIVES CONSIDERED BUT REJECTED FROM FURTHER ANALYSIS

As stated previously, the alternatives evaluated in a DPEA must achieve the purpose and need of the proposed action without violating any of the applicable laws and regulations described in Chapter 6 and summarized in section 1.6. Other potential alternatives that do not satisfy the agency's purpose and need, or would not meet minimum environmental standards, are not considered reasonable and need not be carried forward for evaluation in a DPEA. The following alternatives were considered but rejected because they do not meet the purpose and need as stated in Section 1.3 or the screening criteria described in Section 2.1.

2.6.1 Sole Reliance on Commercial Fishery Data

One alternative that NMFS considered was to rely solely on commercial fisheries data such as Catch Per Unit Effort, seasonal and geographic distribution of harvests, and other harvest data to assess the status of commercially important stocks. This alternative was rejected from further analysis because it would not provide sufficient information on the age/size class structure of exploited fish stocks and would be insufficient to track fish population dynamics or provide other types of predictive capabilities required to manage the fisheries. This approach would also not meet the need to maintain a standardized, objective, and unbiased sampling approach provided by independent surveys.

Conclusion: This alternative does not meet screening criteria 1 or 3. It would not meet statutory obligations because directed research activities would not be conducted. It would not maintain scientific integrity of research programs because the results would not maintain the consistency of data with prior research efforts. For these reasons this alternative is not carried forward for detailed evaluation.

2.6.2 New Methodologies

Another alternative considered was to adopt other types of survey methodologies or develop new methodologies based primarily on their potential to eliminate or greatly reduce interactions with protected species or effects on habitat, as opposed to adopting new methods and gear for fisheries research purposes. Although NMFS continues to place a high priority on avoiding adverse interactions with protected species and is continually reviewing potential mitigation measures for research activities, the purpose and need for conducting fisheries research requires future sampling methodologies be consistent with past data sets to maintain long-term trend analyses for commercially fished and ecologically important species. NMFS is currently evaluating alternative sampling methods for fisheries and marine ecosystem research, some of which may reduce the potential for incidental takes of protected species or effects on benthic habitats. However, these new methodologies will be evaluated primarily for consistency with the purpose and need for fisheries and marine ecosystem research and whether they provide information that can build on and supplement past data sets.

Conclusion: This alternative did not meet screening criterion 3. It would not maintain scientific integrity of research programs because the results would not maintain the consistency of data with prior research efforts. Therefore, this alternative is not carried forward for detailed evaluation.

2.6.3 Alternative Research Program Design

In this alternative the types of research conducted would be revised to determine if alternative levels of a particular research would result in different levels of impacts. The design of research programs is a scientific process, not a policy decision. This alternative would emphasize minimizing potential adverse environmental impacts when designing research activities. Other factors, such as maximizing efficient use of scientific research funding and maintaining the integrity of long-term data sets, would not be considered in this approach.

Conclusion: This alternative was rejected because it would not meet screening criterion 3 and would intrude on inherently technical and scientific decisions. Therefore, this alternative is not carried forward for detailed evaluation.

3.1 PHYSICAL ENVIRONMENT

The geographic areas and physical environments potentially affected by the Northwest Fisheries Science Center's (NWFSC) research surveys are located in the California Current area of the Pacific Ocean, as well as in Puget Sound, the lower Columbia River, and associated estuaries. These areas are located primarily within the California Current Large Marine Ecosystem, however, NWFSC research surveys occur both inside and outside the LME, and sometimes span across multiple ecological, physical, and political boundaries.

3.1.1 Large Marine Ecosystems

Large Marine Ecosystems (LMEs) are large areas of coastal ocean space. LMEs generally include greater than 200,000 square kilometers (km²) of ocean surface area, and are located in coastal waters where primary productivity is generally higher than in open ocean areas. LME physical boundaries are based on four ecological criteria: bathymetry, hydrography, productivity, and trophic relationships. Based on these four criteria, 10 LMEs have been delineated for the coastal marine waters of the U.S., and a total of 64 distinct LMEs have been delineated around the coastal margins of the Atlantic, Pacific and Indian Oceans (Sherman et al. 2004). Figure 3.1-1 shows the world's LMEs as defined at www.lme.noaa.gov. Each color represents a distinct LME.

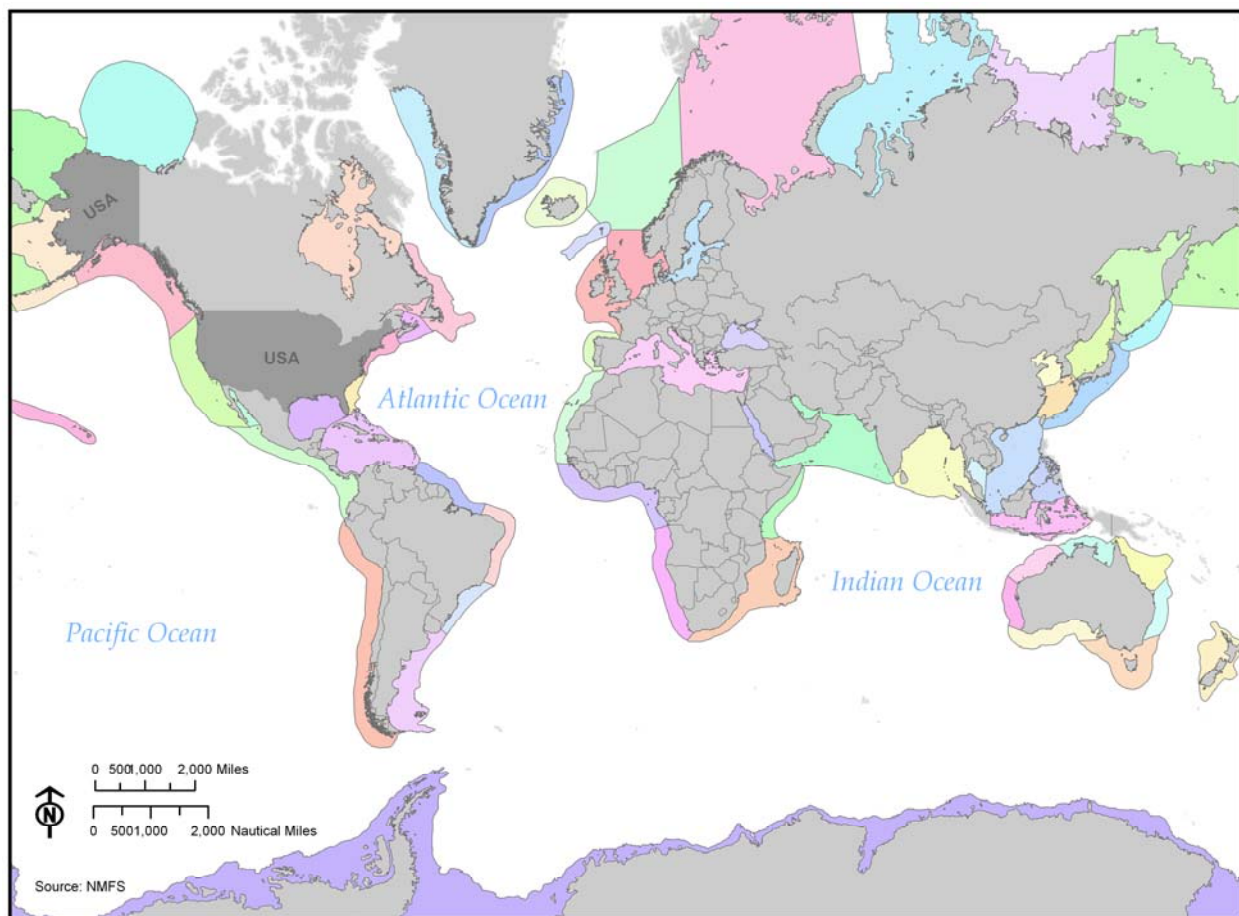


Figure 3.1-1 Large Marine Ecosystems of the World

Globally, LMEs are the source of 80 to 95 percent of the world's marine fish harvest, and are centers of economic activity for oil and gas, shipping, and tourism industries. The LME concept provides a practical framework for the application of ecosystem-based approaches to fisheries assessment and management, habitat restoration, and research on pollution and ecosystem health. The National Oceanic and Atmospheric Administration (NOAA) and National Marine Fisheries Service (NMFS) have implemented a management approach designed to improve the long-term sustainability of LMEs and their resources by using practices that focus on ensuring the sustainability of the productive potential for ecosystem goods and services. For more detailed information on the LME management concept and trends in ecosystem health, see *The UNEP [United Nations Environmental Program] Large Marine Ecosystem Report: A perspective on changing conditions in LMEs of the world's Regional Seas* (Sherman and Hempel 2008).

NWFSC's fisheries research activities take place in three primary research areas: the California Current Research Area (CCRA), the Puget Sound Research Area (PSRA), and the Lower Columbia River Research Area (LCRRA), which are described in detail in the following sections. These areas are located primarily within the California Current LME. However, a substantial amount of the NWFSC fisheries research activities are also conducted in estuarine areas that are not considered to be within the boundaries of the California Current LME.

3.1.1.1 California Current

The NWFSC conducts research surveys in the CCRA, both inside and outside of the LME boundaries (Figure 1.1-2). The California Current LME has a surface area of about 2.2 million km² and is bordered by the U.S. and Mexico.

The California Current moves south along the western coast of North America, beginning off southern British Columbia, flowing southward past Washington, Oregon and California, and ending off southern Baja California (Bograd et al. 2010). The California Current is part of the North Pacific Gyre and brings cool waters southward. Additionally, extensive upwelling of colder sub-surface waters supports large populations of whales, seabirds and important fisheries along the West Coast of the U.S. (Sherman and Hempel 2008). Characteristics of the California Current (such as productivity) can vary as a result of coastal upwelling and the Pacific Decadal Oscillation (PDO): a 20-30-year cooling and warming cycle between cool and productive ocean regime and a warm and unproductive ocean regime (Sherman and Hempel 2009). The California Current LME includes coastal areas where NWFSC conducts research surveys for rockfishes, coastal pelagics and numerous other species. However the NWFSC also conducts research that extends into deeper waters beyond the California Current LME boundary.

On the shoreward side of the California Current, the California Current Front (CCF) separates cold low-salinity upwelled waters from the warmer saltier waters close to shore. Offshore frontal filaments transport the frontal water across the entire LME. In winter, the Davidson Current Front forms along the boundary between inshore subtropical waters and colder offshore temperate and subarctic waters (see Figure 3.1-2) (Sherman and Hempel 2008).

The California Current determines the general hydrography off the coast of the California. The current is related to the anticyclonic circulation of the central North Pacific. In general, an area of divergence parallels the coast of California, with a zone of convergence 200-300 kilometers (km.) (124-186 miles [mi.]) from the coastline. Surface flow of the California Current appears to be diverted offshore at Point Conception and again at Punta Eugenia, while semi-permanent eddies exist south of these headlands. These eddies contribute to the recruitment of pelagic larvae to the adult species populations in these areas (Hewitt 1981).

In addition, there is some indication that a southward undercurrent, the Washington Undercurrent, occurs over the continental slope of Washington and Oregon in the winter (Werner and Hickey 1983; Purdy

1990). This undercurrent is located 1,000 to 1,600 feet deep, deeper than the northward flowing California Undercurrent (Hickey 1998 et al.; Hickey and Banas 2003).

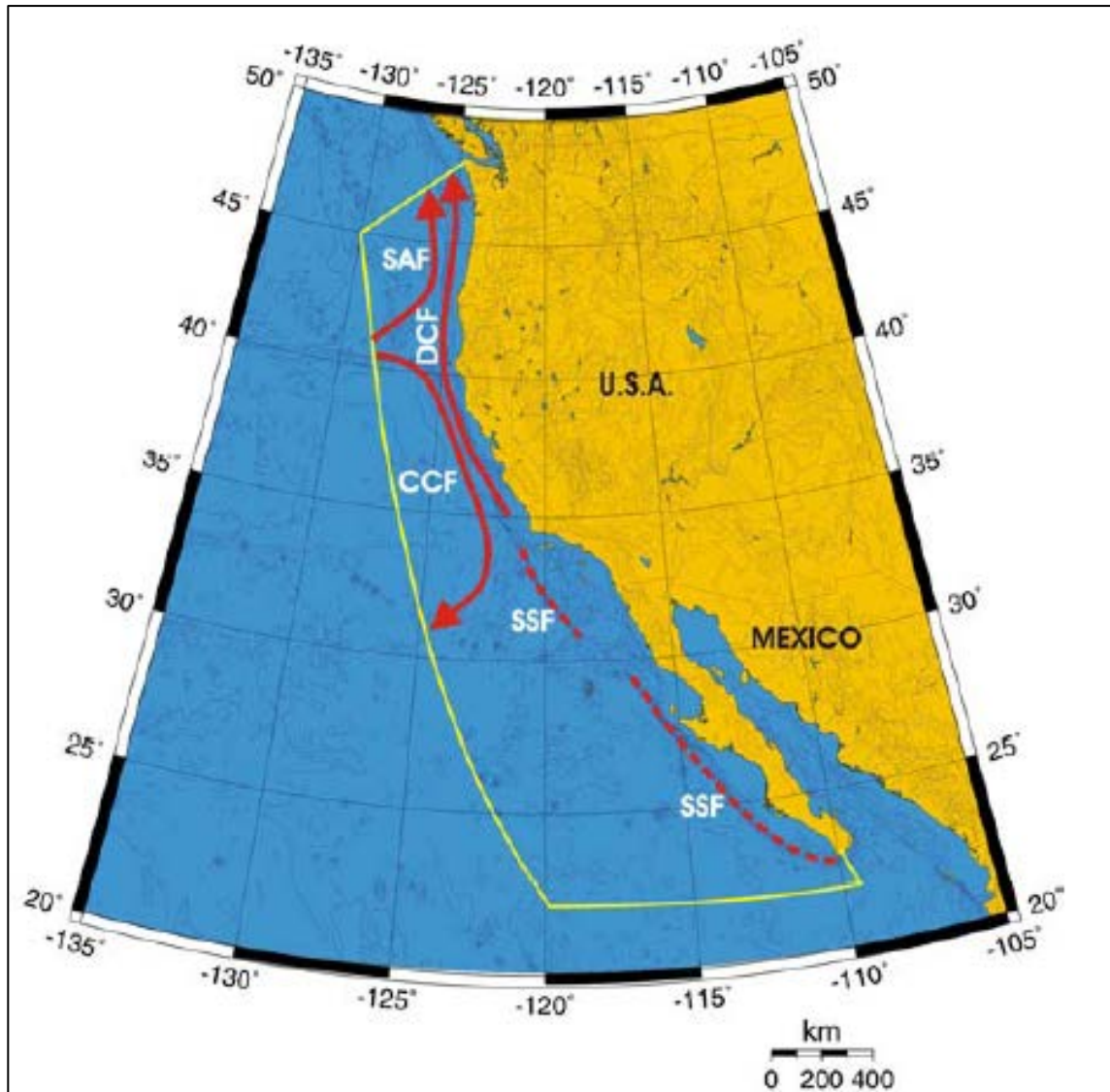


Figure 3.1-2 Oceanographic Fronts of the California Current.

Figure shows the California Current Front (CCF), Davidson Current Front (DCF), Subarctic Front (SAF), Shelf Slope Front (SSF), and the California Current LME boundary (yellow line) (from Sherman and Hempel 2008; Belkin et al. 2009).

3.1.1.2 Puget Sound

Puget Sound is an estuary located in northwest Washington State (Figure 1.1-3). It is one of the largest estuaries in the United States and it is the only inland sea with fjords in the lower 48 states. It has more than 8,000 km² (2 million acres) of marine waters and estuarine environment and has a watershed of more than 33,000 km² (8.3 million acres) (Fresh et al. 2011). The average depth of Puget Sound is 62.5 m at mean low tide, and its maximum depth, near Point Jefferson between Indianola and Kingston, is 930 feet (280 m). The depth of the main basin, between the southern tip of Whidbey Island and Tacoma, Washington, is approximately 600 feet (180 m). The average surface water temperature is 12.8 degrees C in summer and 7.2 degrees C in winter (Staubitz et al. 1997). The circulation of water in Puget Sound is

driven by tides, gravity, and freshwater influx. Mean daily differences between high and low tide depend on the location within the sound, and vary from 2.4 m at the northern end of the sound to 4.6 m at the southern end. The freshwater inflow into Puget Sound is about 900 million gallons/day (gpd) (3.4 trillion liters /day) Rivers (Gustafson et al. 2000). The Fraser River is the largest source of river load into Puget Sound (Mohamedali et al. 2011).

Concentrations of nutrients (i.e., nitrates and phosphates) are consistently high throughout most of Puget Sound, largely due to the flux of oceanic water into the basin (Harrison et al. 1994).

Puget Sound is a place of great physical and ecological complexity and productivity. Many diverse and important habitat types occur in Puget Sound; kelp beds and eelgrass meadows cover almost 1000 km², while other major habitat types include subtidal and intertidal wetlands (176 km²), and mudflats and sandflats (246 km²) (Gustafson et al. 2000). Substantial changes in the relative proportions of habitat types have occurred over the last century due to human influences. For example, Hutchinson (1988) indicated that 58 % of Puget Sound intertidal habitat has been lost since European settlement, and at least 76% of the wetlands around Puget Sound have been eliminated, especially in urbanized estuaries. Large areas of mudflats and sandflats have also been eliminated (Gustafson et al. 2000). The human population in the Puget Sound region is estimated to be about 3.6 million (Gustafson et al. 2000).

3.1.1.3 Lower Columbia River

The Lower Columbia River Research Area includes the Columbia River from Bonneville Dam to the mouth of the Columbia River west of Astoria, Oregon (Figure 1.1-4). Bonneville Lock and Dam is located 145 river miles (RM) from the mouth of the Columbia River and about 40 miles east of Portland, Oregon, near Cascade Locks, Oregon, and North Bonneville, Washington. The Columbia River emerges from the gorge about 20 miles east of Portland. Downstream of Washougal, WA and Troutdale, OR, the river valley widens to include a broad floodplain; elongated islands divide the river and form sloughs and side-channels in the formerly marshy lowlands. The floodplain expands around the river's confluence with the Willamette River, where the sloughs and lakes of North Portland, Sauvie Island, and the Vancouver lowlands contain the metropolitan area's last major remnants of the swampy riparian system formerly nourished by annual flooding of the non-dammed rivers. Downstream from St. Helens, OR the Columbia cuts through the Coast Range, a passage marked by steep-shouldered bluffs and broad alluvial floodplains. Downstream of Skamokawa, WA the river channel, dotted with low islands of deposited sediments throughout its lower reaches, widens into several broad bays that extend more than 30 miles to the Pacific Ocean (Pacific Coast Joint Venture 1994).

With the exception of the Willamette River, most of the lower Columbia's tributaries drain out of relatively short watersheds. Major streams originating in the Cascade Mountains include the Willamette and Sandy Rivers in Oregon and the Washougal, Lewis, Kalama, and Cowlitz Rivers in Washington.

The Columbia River estuary is one of the West Coast's largest, encompassing more than 325 km² (80,000 acres). Dams, diking, and dredging have dramatically altered the hydrologic processes that historically shaped the wetlands of the lower Columbia River. Before the dams were built, many of the islands and much of the floodplain were inundated several times a year, typically in December and again in May or June. Operation of the dams on the Columbia's main stem and major tributaries has substantially reduced peak river flows, and has nearly eliminated flooding in many low-lying areas. Dredging of shipping channels has required disposal of massive quantities of sediments, resulting in creation of new islands, filling of many former wetlands, and changing shoreline sediment types (Pacific Coast Joint Venture 1994).

The Columbia River plume has a major effect on the coastal oceanography of the Pacific Northwest through its influence on sea surface salinity. In general, salinity increases southward along the Pacific coast (Hickey and Banas 2003). However, the low-salinity plume of freshwater discharge from the

Columbia River constantly changes direction, depth, and width in response to variation in discharge and fluctuations in local wind strength and direction (Hickey et al. 1998; Berdeal et al. 2002; Hickey and Banas 2003). In spring and summer, the plume moves southward, well offshore of the Oregon shelf (Hickey and Banas 2003). During winter the plume flows northward and can generate local currents with magnitudes on the order of wind-driven currents in the near-surface layer (Hickey et al. 1998). In addition to seasonal variability, the structure and magnitude of the Columbia River plume has significant interannual and long-term variability (Hickey and Banas 2003). For example, in years of high snowmelt in the Pacific Northwest, freshwater generated from the plume can influence coastal oceanography for prolonged periods (NMFS 2008a).

3.1.2 Special Resource Areas

3.1.2.1 Essential Fish Habitat

Essential Fish Habitat (EFH) is comprised of the waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (16 United States Code [U.S.C.] 1802 sec. 3(10)). Regulatory guidelines explain that EFH should be sufficient to “support a population adequate to maintain a sustainable fishery and the managed species’ contributions to a healthy ecosystem” (50 Code of Federal Regulations [CFR] 600, subpart J). EFH applies to federally managed species in both state and federal jurisdictional waters throughout the range of the species within U.S. waters. Where a species’ range extends beyond U.S. waters, EFH stops at the boundary. Therefore, no EFH exists outside the U.S. EEZ.

The designation of EFH by itself does not confer any protection of the areas from non-fishing or fishing impacts. Instead, it is a tool used by managers to reduce impacts and improve fisheries management. It is described and identified in Fishery Management Plans (FMPs) that are developed by regional Fishery Management Councils. NMFS regional offices implement FMPs to facilitate long-term protection of EFH through conservation and management measures.

The EFH for a managed species is designated separately for each life stage: eggs, larvae (normally pelagic), juveniles, and adults (pelagic and/or demersal). In certain species EFH is also designated for spawning adults. Many species require different habitats for different life stages, sometimes resulting in vast areas of EFH for a single species. Overlapping EFH areas for numerous federally managed species, including over 82 species covered by the Pacific Coast Groundfish FMP, have been identified in areas where NWFSC research surveys occur (Pacific Fishery Management Council [PFMC] 2008). Descriptions of groundfish EFH for the various life stages of each of the species result in the definition of over 400 distinct EFH areas.

As shown in Figure 3.1-3, when EFH areas are combined, groundfish EFH includes all waters less than 3,500 meters (m) in depth from the mean higher high water line, and the upriver extent of saltwater intrusion in river mouths, to the seaward boundary of the U.S. EEZ along the coasts of California, Oregon, and Washington (PFMC 2008). As part of Amendment 19 to the Pacific Coast Groundfish FMP, PFMC has identified areas that are closed to fishing with specified gear types, or are only open to fishing with specified gear types (see definitions of gear types in 71 FR 27408). These Essential Fish Habitat Closed Areas (EFHCA) are intended to mitigate the adverse effects of fishing on groundfish EFH. There are five bottom trawl closed areas (BTCA) off of Washington, nine off of Oregon, and 20 off of California. For the BTCA off of California, the demersal seine is not considered bottom trawl gear. There are also two bottom contact closed areas (BCCA) off of Oregon and 14 off of California. At Davidson Seamount, one of the BCCA off of California, fishing with bottom contact gear, or any other gear that is deployed deeper than 500 fathoms (914 m) is prohibited. Amendment 19 also established the bottom trawl footprint closure which prohibits bottom trawling in groundfish EFH seaward of the 700-fathom (1,280-m) isobath. The locations of EFHCAs, as well as the bottom trawl footprint closure, are shown in Figure 3.1-4. Amendment 19 also prohibits the following activities:

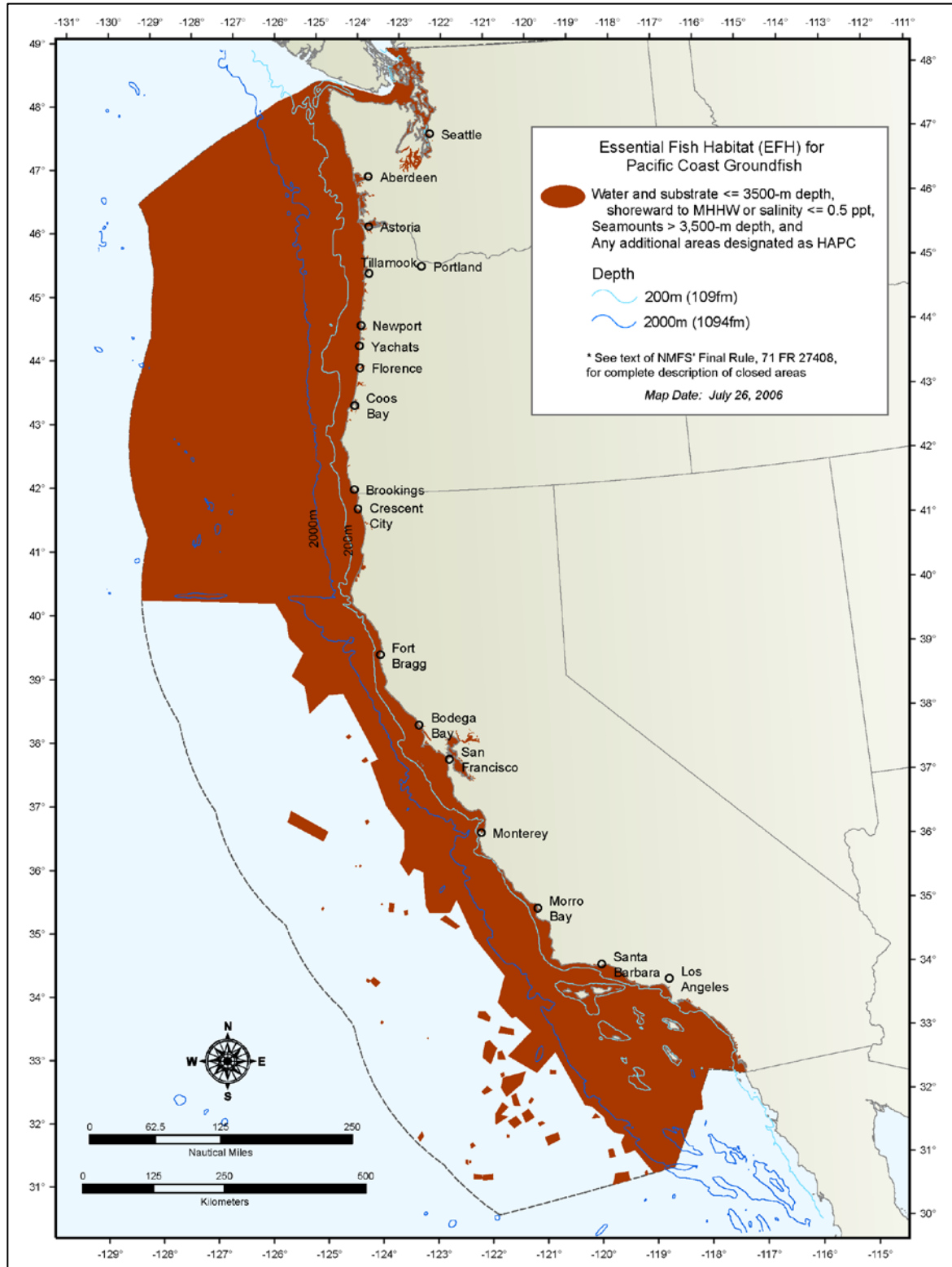
- Fishing with dredge gear anywhere within Pacific Coast groundfish EFH
- Fishing with beam trawl gear anywhere within Pacific Coast groundfish EFH
- Fishing with bottom trawl gear with a footrope diameter greater than 19 inches (48 cm) anywhere within Pacific Coast groundfish EFH
- Fishing with bottom trawl gear with a footrope diameter (including rollers, bobbins, or other material encircling or tied along the length of the footrope) greater than 8 inches (20 cm) anywhere within the Pacific Coast U.S. EEZ shoreward of the 100-fathom (183-m isobath)

Detailed information on the restrictions on EFHCAs can be found in the NOAA Fisheries West Coast Region Closed Areas Website (NOAA 2014a), available online at: http://www.westcoast.fisheries.noaa.gov/fisheries/management/groundfish_closures/groundfish_closed_areas.html. The State of Washington does not allow commercial fishing within its territorial waters (0-3 miles from the coastline) and therefore a nearshore commercial fixed gear fleet does not operate in Washington. The states of California, Oregon, and Washington have established additional closed areas within state waters.

Per Chapter 9 of the Pacific Coast Groundfish FMP, scientific research involving groundfish can be exempted from the EFH groundfish closed areas and other regulations specified in the FMP. To qualify for an exemption, a research proposal, addressing certain criteria, must be submitted in writing to the Secretary of Commerce or his delegate. If the Secretary or his delegate agrees that the activity constitutes scientific research; a letter of acknowledgement detailing the approved purpose, scope, location, and schedule; will be issued to the operator or master of the vessel conducting the scientific research (PFMC 2014a).

The Coastal Pelagic Species (CPS) FMP describes EFH for five pelagic species: northern anchovy, Pacific sardine, Pacific (chub) mackerel, jack mackerel and market squid (PFMC 1998). These four finfish and one squid are treated as a single species complex because of similarities in their life histories and habitat requirements. Krill was added to the FMP as an essential component of the California Current Ecosystem under amendment 12 of the CPS FMP in February 2008. EFH for these CPS includes all marine and estuarine waters above the thermocline where sea surface temperatures range between 10 and 26 C° along the coasts of California, Oregon, and Washington from the shoreline to the seaward boundary of the U.S. EEZ. The southern boundary of the EFH area for CPS is effectively the maritime boundary between U.S. and Mexican waters while the northern boundary for the EFH area is defined by the 10 C° isotherm, the location of which changes seasonally and annually (PFMC 1998).

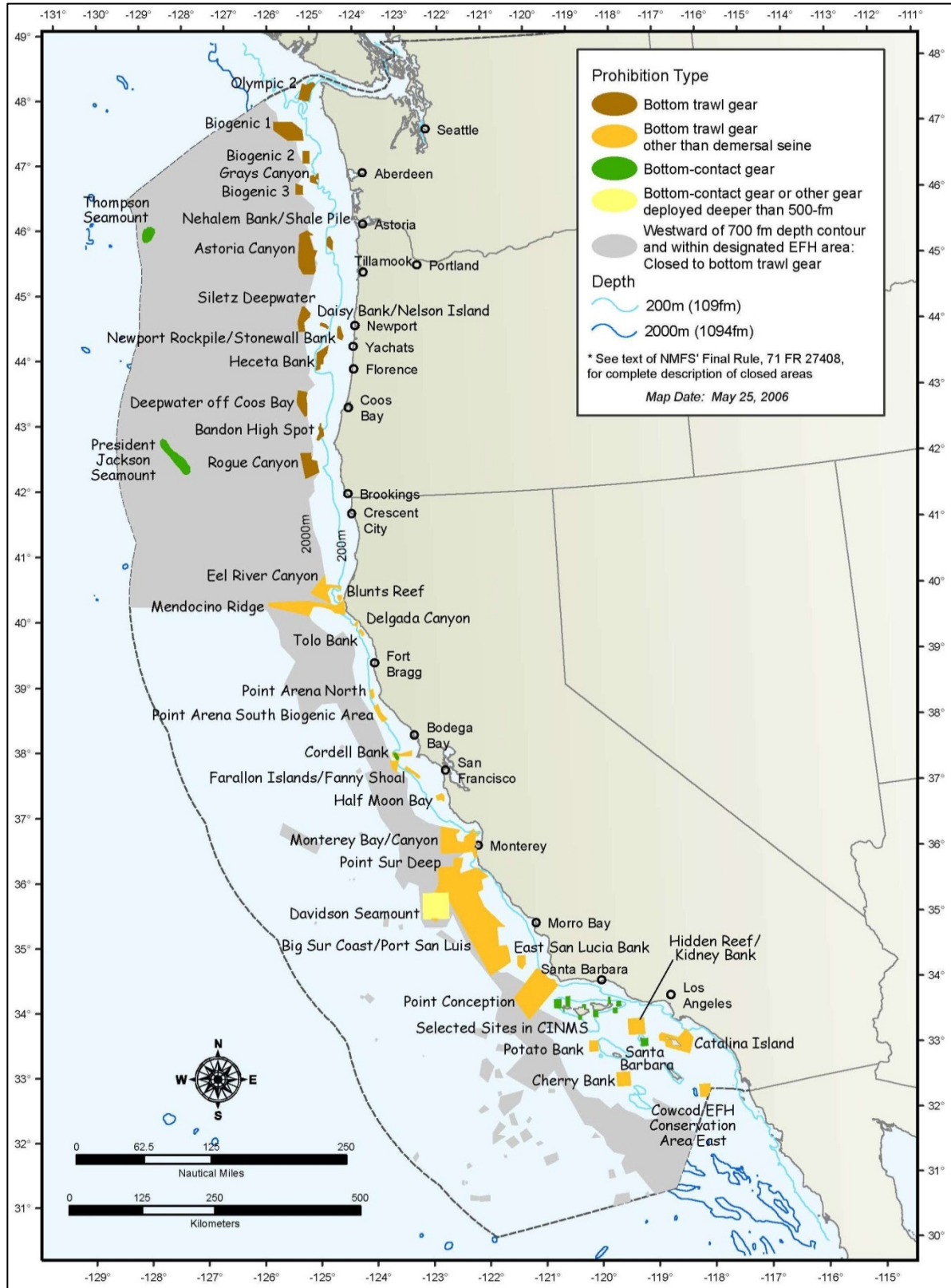
Three species of salmon (Chinook, coho, and pink) are covered by the Pacific Salmon FMP (PFMC 2003). In estuarine and marine areas, salmon EFH extends from the nearshore and tidal submerged environments within state territorial waters to the seaward boundary of the U.S. EEZ along the coasts of Washington, Oregon, and California north of Point Conception. The Pacific Salmon FMP also includes the salmon EFH in marine areas off the coast of Alaska designated by the North Pacific Fishery Management Council (NPFMC). Freshwater EFH for Pacific salmon includes all streams, lakes, ponds, wetlands, and other water bodies currently or historically accessible to salmon in Washington, Oregon, Idaho, and California, with the exception of areas upstream of certain impassable manmade barriers (as identified by the PFMC), and upstream of longstanding, naturally-impassable barriers (i.e., natural waterfalls in existence for several hundred years) (PFMC 2003).



Source: <http://www.pcouncil.org/wp-content/uploads/A18-19Final.pdf>

Figure 3.1-3 Essential Fish Habitat for Pacific Coast Groundfish

From Amendment 19 to the Pacific Coast Groundfish FMP (PFMC 2008).



Source: http://www.pcouncil.org/wp-content/uploads/EFH_Cons_Areas.pdf

Figure 3.1-4 Essential Fish Habitat Closure Areas to Protect Pacific Coast Groundfish Habitat

The FMP for U.S. West Coast Fisheries for Highly Migratory Species (HMS) defines EFH for thirteen species (common thresher shark, pelagic thresher shark, bigeye thresher shark, shortfin mako shark, blue shark, albacore tuna, bigeye tuna, northern bluefin tuna, skipjack tuna, yellowfin tuna, striped marlin, swordfish, and dorado or dolphinfish) (PFMC 2007). The combined EFH for these species includes a large fraction of the pelagic marine waters within the U.S. EEZ along the coasts of California, Oregon, and Washington.

3.1.2.2 Habitat Areas of Particular Concern

The EFH provisions of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (50 CFR part 600) recommend that specific areas of habitat within EFH are identified as “habitat areas of particular concern.” Habitat Areas of Particular Concern (HAPC) are discrete subsets of EFH that provide important ecological functions or are especially vulnerable to degradation. FMCs may designate a specific habitat area as a HAPC for one or more of the following reasons: the importance of the ecological function provided by the habitat; the extent to which the habitat is sensitive to human-induced environmental degradation; whether and to what extent development activities are, or will be, stressing the habitat type; and the rarity of habitat type.

The intended goal of identifying HAPC is to focus conservation efforts on the most important areas. While the HAPC designation does not trigger any specific regulatory process or confer any specific protection, it highlights certain habitat types that are of high ecological value. This designation is manifested in EFH consultations, during which NMFS can recommend protective measures for specific HAPC.

Several FMCs have designated discrete habitat areas as HAPC, while others have broadly designated all areas of a specific habitat type as HAPCs. The PFMC has only designated HAPC for Pacific Coast groundfish. Pacific Coast groundfish HAPC includes: seagrasses, canopy kelp, estuaries, rocky reefs, and a number of clearly defined areas of interest. For detailed descriptions of Pacific Coast groundfish HAPC, refer to the Pacific Coast Groundfish FMP (PFMC 2014a).

3.1.2.3 Marine Protected Areas

An MPA is defined by Executive Order (EO) 13158 as “any area of the marine environment that has been reserved by federal, state, tribal, territorial, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein.” They are a group of sites, networks, and systems established and managed by federal, state, tribal, and local governments. Most MPAs have legally established goals, conservation objectives, and intended purposes. MPAs generally address one or more of three areas of conservation focus:

Natural Heritage: established and managed wholly or in part to sustain, conserve, restore, and understand the protected area’s natural biodiversity, populations, communities, habitats, and ecosystems; the ecological and physical processes upon which they depend; and, the ecological services, human uses and values they provide to this and future generations.

Cultural Heritage: established and managed wholly or in part to protect and understand submerged cultural resources that reflect the nation’s maritime history and traditional cultural connections to the sea.

Sustainable Production: established and managed wholly or in part with the explicit purpose of supporting the continued extraction of renewable living resources (such as fish, shellfish, plants, birds, or mammals) that live within the MPA, or that are exploited elsewhere but depend upon the protected area’s habitat for essential aspects of their ecology or life history.

MPAs encompass almost the entire area where research surveys are conducted. They contain: state MPAs, including State Marine Reserves (SMRs), State Marine Parks (SMPs), State Marine Conservation

Areas (SMCAs), and State Marine Recreational Management Areas (SMRMAs); National Wildlife Refuges; National Park Service MPAs; and National Marine Sanctuaries. MPAs vary widely in the level and type of legal protection afforded to the site's natural and cultural resources and ecological processes. Many of the MPAs within the NWFSC research areas have various levels of fishing restrictions. Details of MPAs located within the U.S. EEZ, can be found on the List of National System MPAs (NOAA 2013a). This list also includes Habitat Closed Areas and Closed Areas (see Section 3.1.2.3). Although Habitat Closed Areas and Closed Areas are not formally classified as marine reserves, they provide similar levels of protection for many species.

The National Marine Sanctuaries Act (NMSA) authorizes the Secretary of Commerce to designate and protect areas of the marine environment with special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archeological, educational, or esthetic qualities as national marine sanctuaries. Day-to-day management of national marine sanctuaries has been delegated by the Secretary of Commerce to NOAA's Office of National Marine Sanctuaries. The primary objective of the NMSA is to protect marine resources, such as coral reefs, sunken historical vessels or unique habitats. The National Marine Sanctuary System consists of 14 MPAs that encompass more than 150,000 square miles of marine and Great Lakes waters. There are five National Marine Sanctuaries that are within the CCRA (Figure 3.1-5).

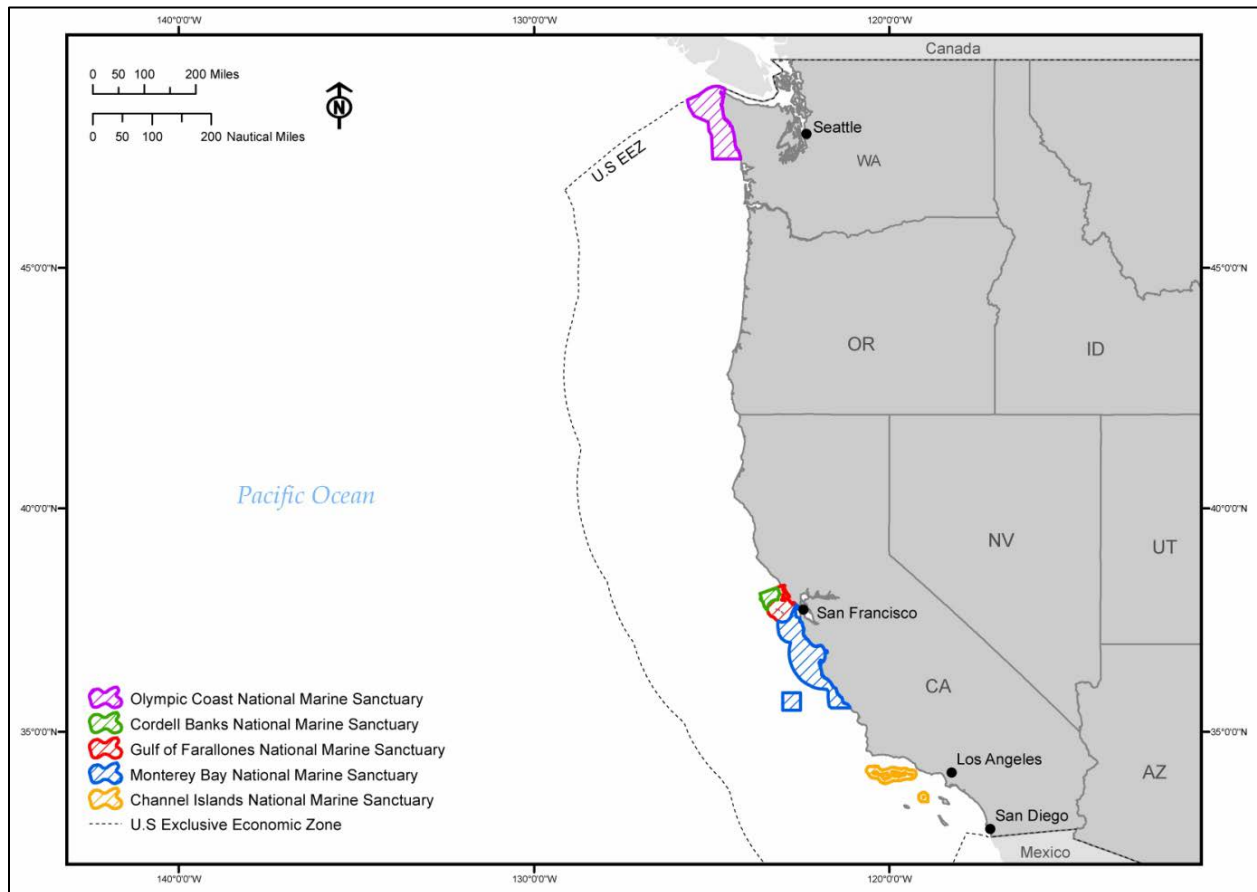


Figure 3.1-5 National Marine Sanctuaries in the CCRA

Olympic Coast National Marine Sanctuary (OCNMS) includes 3,189 square miles (mi²) (2,408 square nautical miles [nm²]) of marine waters off the Olympic Peninsula coastline and is located within the combined usual and accustomed harvest areas of the Coastal Treaty Tribes (CTT). The sanctuary extends 25 to 50 miles seaward, covering much of the continental shelf and several major submarine canyons. The sanctuary protects a productive upwelling zone, including habitat for marine mammals and seabirds. Along its shores are thriving kelp and intertidal communities. On the seafloor, scattered communities of deep sea coral and sponges form habitats for fish and other important marine wildlife. Pursuant to federal court decisions under the U.S. v Washington umbrella, the four treaty tribes are recognized to have a property interest in all of the vertebrate and invertebrate marine life within their marine treaty boundaries and accordingly, must be included in management decisions regarding these marine species.

Cordell Bank National Marine Sanctuary was established in 1989 to protect and preserve the extraordinary marine ecosystem surrounding the Cordell Bank. Surrounded by soft sediments of the continental shelf seafloor, Cordell Bank consists of a rocky habitat, which supports a diverse population of invertebrates, algae, and fishes. The productive waters attract migratory seabirds and marine mammals from throughout the Pacific Ocean to feed in this dynamic food web. With its southernmost boundary located 42 miles north of San Francisco the sanctuary is entirely offshore, with the eastern boundary six miles from shore and the western boundary 30 miles offshore. In total, the sanctuary protects an area of 529 square miles.

Gulf of the Farallones National Marine Sanctuary spans 1,279 square miles just north and west of San Francisco Bay, and protects open ocean, nearshore tidal flats, rocky intertidal areas, estuarine wetlands, subtidal reefs, and coastal beaches within its boundaries. In addition, the sanctuary has administrative jurisdiction over the northern portion of the Monterey Bay National Marine Sanctuary, from the San Mateo/Santa Cruz County line northward to the existing boundary between the two sanctuaries and maintains an office in San Francisco. It provides breeding and feeding grounds for at least 25 endangered or threatened species; 36 marine mammal species, including blue, gray, and humpback whales, harbor seals, elephant seals, Pacific white-sided dolphins, Steller sea lions; over a quarter-million breeding seabirds; and a significant population of white sharks.

Monterey Bay National Marine Sanctuary is a federally protected marine area off California's central coast designated in 1992. The sanctuary encompasses a shoreline length of 276 miles and 6,094 square miles of ocean, extending an average distance of 30 miles from shore. It was established for the purposes of resource protection, research, education and public use. Its natural resources include our nation's largest kelp forest, one of North America's largest underwater canyons, and the closest-to-shore deep ocean environment in the continental U.S. The sanctuary provides habitat for 33 species of marine mammals, 94 species of seabirds, 345 species of fishes, and numerous invertebrates and plants.

Channel Islands National Marine Sanctuary consists of an area of approximately 1,470 square miles off the coast of southern California. It is adjacent to the following islands and offshore rocks: San Miguel Island, Santa Cruz Island, Santa Rosa Island, Anacapa Island, Santa Barbara Island, Richardson Rock, and Castle Rock extending seaward to a distance of approximately six nautical miles. The islands and rocks vary in distance from 12 to 40 nautical miles offshore from Santa Barbara and Ventura counties. A fertile combination of warm and cool currents in this area results in a diversity of plants and animals including kelp forests, fish and invertebrates, pinnipeds, cetaceans and sea birds. The sanctuary also has a wealth of maritime heritage resources including Chumash Native American artifacts and more than 100 historic shipwrecks. Human uses in the area include commercial and recreational fishing, marine wildlife viewing, boating, diving, kayaking, maritime shipping, nearby offshore oil and gas development, research and monitoring, military and numerous educational activities.

3.2 BIOLOGICAL ENVIRONMENT

3.2.1 Fish

Numerous finfish species occur within the three NWFSC research areas: CCRA, PSRA and LCRRRA. During the long history of fisheries surveys conducted by the NWFSC in these research areas, many species have been collected and identified. This section of the Environmental Assessment (EA) provides baseline information on species important to the analysis of effects in Chapter 4; Endangered Species Act (ESA)-listed species, important target species, and prohibited species. For the purpose of this DPEA, only target species with a combined research catch from all surveys on NOAA vessels and NOAA chartered vessels of at least 1 mt are described in this chapter.

3.2.1.1 Threatened and Endangered Fish Species

Listed species refer to those with federal and/or state threatened, endangered, or proposed status. Listing status for each distinct population segment (DPS) and occurrence of each species in the different NWFSC research areas are listed in Table 3.2-1. NMFS uses the “evolutionarily significant unit” (ESU) concept to list Pacific salmon, which are essentially equivalent to DPSs for the purpose of the ESA (79 FR 20802, April 14, 2014). Salmon species listed under the ESA will be referred to by the ESU nomenclature for the purposes of this DPEA.

Table 3.2-1 Occurrence of ESA-listed Fish Species within NWFSC Fisheries Research Areas

ESA-listed Species: Distinct Population Segment (DPS)	Status	California Current Research Area	Puget Sound Research Area	Lower Columbia River Research Area
Bocaccio: Puget Sound / Georgia Basin DPS	Endangered	X	X	
Canary rockfish: Puget Sound / Georgia Basin DPS	Threatened		X	
Green sturgeon: Southern DPS	Threatened	X	X	X
Pacific eulachon: Southern DPS	Threatened	X	X	X
Yelloweye rockfish: Puget Sound / Georgia Basin DPS	Threatened	X	X	
SALMONIDS				
Bull Trout DPS				
Columbia River DPS	Threatened	X	X	X
Puget Sound/Coastal DPS	Threatened	X	X	
Chinook Salmon Evolutionarily Significant Units (ESU)				
California Coastal	Threatened	X		
Central Valley Spring-run	Threatened	X		
Lower Columbia River	Threatened	X		X
Puget Sound	Threatened	X	X	
Sacramento River Winter-run	Endangered	X		
Snake River Fall-run	Threatened	X		X
Snake River Spring/Summer-run	Threatened	X		X

ESA-listed Species: Distinct Population Segment (DPS)	Status	California Current Research Area	Puget Sound Research Area	Lower Columbia River Research Area
Upper Columbia River Spring-run	Endangered	X		X
Upper Willamette River	Threatened	X		X
Chum Salmon ESU				
Columbia River	Threatened	X		X
Hood Canal Summer- run	Threatened	X	X	
Coho Salmon ESU				
Central California Coast	Endangered	X		
Lower Columbia River	Threatened	X		X
Oregon Coast	Threatened	X		
Southern Oregon/Northern California Coast	Threatened	X		
Sockeye Salmon ESU				
Ozette Lake	Threatened	X	X	
Snake River	Endangered	X		X
Steelhead DPS				
Central Valley	Threatened	X		
Central California Coast	Threatened	X		
Lower Columbia River	Threatened	X		X
Middle Columbia River	Threatened	X		X
Northern California	Threatened	X		
Puget Sound	Threatened	X	X	
Snake River	Threatened	X		X
South Central California Coast	Threatened	X		
Southern California	Endangered	X		
Upper Columbia River	Threatened	X		X
Upper Willamette River	Threatened	X		X

Puget Sound, the Columbia River and the coastal Pacific waters are known to support listed anadromous salmonids, including Chinook salmon (*Oncorhynchus tshawytscha*), chum salmon (*O. keta*), sockeye salmon (*O. nerka*), steelhead trout (*O. mykiss*), and coho salmon (*O. kisutch*), as well as species of concern (SOC) such as the northern distinct population segment (DPS) of green sturgeon (*Acipenser medirostris*). Habitat use for these species is primarily migration, holding, and rearing.

The information presented in the following species accounts is primarily from the NOAA Fisheries Office of Protected Resources (OPR) website (NMFS 2014a).

Bocaccio

The bocaccio (*Sebastes paucispinis*) is a Pacific coast rockfish that ranges from Punta Blanca, Baja California to the western Gulf of Alaska, but is most commonly observed between Oregon and northern Baja California. Bocaccio are most common between 160 and 820 ft. (50-250 m.) depth, but may be found as deep as 1,560 ft. (475 m.). Adults generally move into deeper water as they increase in size and age and typically exhibit strong site fidelity to rocky bottoms and outcrops. Juveniles and subadults may be more common than adults in shallower water, and are associated with rocky reefs, kelp canopies, and artificial structures, such as piers and oil platforms. Like all rockfish species of the genus *Sebastes*, fertilization and embryo development is internal and female rockfish give birth to live larval young. Larvae are found in surface waters and may be distributed over a wide geographic area extending several hundred miles offshore. It is theorized that larvae and small juveniles remain in open waters for several months, being passively dispersed by ocean currents. Bocaccio are difficult to age, but it is thought that approximately 50 percent of adult Bocaccio mature in 4 to 6 years and scientists suspect they can live as long as 50 years. Bocaccio are fished for directly and are often caught as bycatch in commercial fisheries, such as the salmon fishery. Fishing restrictions have been placed on this endangered species since they are slow-growing, late to mature, and long lived; which means even if threats are no longer affecting the species, recovery will take many years (NMFS 2014a).

Bocaccio off the West Coast is comprised of three distinct population segments (DPS): a northern coastal population extending from British Columbia south to the California/Oregon border, a southern coastal population extending from there to Mexico (currently listed as a Species of Concern (SOC)), and a Puget Sound/Georgia Basin population, listed as endangered under the ESA in 2010. The Puget Sound/Georgia Basin DPS was listed as endangered due to declining species numbers and uncertainty over the population levels within the DPS. Critical habitat was recently designated for several rockfish species in Puget Sound, including this DPS of bocaccio (79 FR 68042, November, 14, 2014). Fishing restrictions have been placed on this species since they are slow-growing, late to mature, and long lived; which means even if threats are no longer affecting the species, recovery will take many years (NMFS 2012a).

DeLacy et al. (1972) and Miller and Borton (1980) compiled all available data on Puget Sound fish species distributions and relative number of occurrences through the mid-1970s from literature, fish collections, unpublished log records, and other sources. Though bocaccio rockfish was recorded 110 times in these documents, most records were associated with sport catch from the 1970s in Tacoma Narrows and Appletree Cove (near Kingston). At publication time, Drake et al (2010) reported that there had been no confirmed observations of bocaccio rockfish in Puget Sound for approximately 7 years but concluded that bocaccio rockfish likely still occurred in low abundances. In 2014, WDFW confirmed presence of the species in Puget Sound.

The canary rockfish (*Sebastes pinniger*) is a Pacific coast species that ranges between Punta Colnett, Baja California, and the Western Gulf of Alaska. Canary rockfish primarily inhabit waters ranging from 160 to 820 ft. (50 to 250 m.) deep but have been observed up to 1,400 feet (426 meters). It is expected that their habitat requirements are similar to that of other deepwater rockfish species, and they likely reside in deeper waters around rock outcroppings. Approximately 50 percent of adult canary rockfish are mature around 7-1/2 years of age and approximately 16 inches (40.5 centimeters) total length. Canary rockfish are directly fished for and often caught as bycatch in other fisheries, including salmon fisheries. Canary rockfish are long lived, with reports of specimens aged at more than 70 years, and slow to recover from population declines. Various restrictions have been placed on the fishing industry to assist in the recovery of this threatened species (NMFS 2012a). The canary rockfish is comprised of two DPSs, the coastal DPS (which is not ESA-listed) and the Puget Sound/Georgia Basin DPS. The Puget Sound/Georgia Basin DPS was listed as threatened under the ESA in 2010 due to a lack of survey data of population levels of the species, as well as a steady drop off in catch records. Critical habitat was recently designated for several rockfish species in Puget Sound, including this DPS of canary rockfish (79 FR 68042, November, 14,

2014). Canary rockfish were once considered fairly common in the greater Puget Sound area; however, little is known about their habitat requirements in these waters (Drake et al. 2010; Palsson et al. 2009). DeLacy et al. (1972) and Miller and Borton (1980) documented 114 records of canary rockfish prior to the mid-1970s, with most records attributed to sport catch from the 1960s to 1970s in Tacoma Narrows, Hood Canal, San Juan Islands, Bellingham, and Appletree Cove. With the absence of associated catch records, and no recent scientific surveys of these waters, the prevalence of rockfish in these waters remains unknown. Drake et al. (2010) concluded that canary rockfish occur in low and decreasing abundances in Puget Sound.

Green sturgeon

Green sturgeon are the most broadly distributed, wide-ranging, and most marine oriented species of the sturgeon family. The green sturgeon is anadromous and it ranges from Baja California to Alaska (and possibly beyond) in marine waters, and is observed in bays and estuaries up and down the West Coast of North America (Moyle et al. 1995). These fish use both freshwater and saltwater habitat but are known to spend the majority of their lives in nearshore oceanic waters, bays, and estuaries. Sturgeon live near bottom substrate where they consume benthic prey, including shrimp, molluscs, amphipods, and small fishes (Moyle et al. 1992).

The green sturgeon (*Acipenser medirostris*) has two distinct population segments (DPS) within the CCRA, PSRA and LCRRA. The Southern DPS of green sturgeon has been listed as a threatened species under the ESA (71 FR 17757) on April 7, 2006, whereas the Northern DPS of green sturgeon remains an SOC. The Northern DPS of Green sturgeon congregate in coastal bays and estuaries in late summer and early fall, with particularly large concentrations in the Columbia River Estuary, Willapa Bay, and Grays Harbor. They appear to seek out the relatively warm water of these estuaries to optimize growth potential (Moser and Lindley 2007). They are present in non-natal estuaries from June through October, but tagging studies demonstrated movement rates up to 12 km/day as fish swam between Willapa Bay and the Columbia River. Typical size of these fish in Willapa Bay is 4.9 feet (150 cm) with a range of 3.9 to 6.9 feet (120 to 210 centimeters). The Northern DPS of green sturgeon do not usually venture past Juan de Fuca Strait and are rare in Puget Sound. The Southern DPS of green sturgeon forages in estuaries and bays ranging from San Francisco Bay to Oregon and are believed to spawn regularly in the Sacramento River. The Southern DPS are not usually found in Puget Sound.

Juvenile green sturgeon reside in fresh water, while adults only return to deep pools in large, turbulent, freshwater rivers to spawn after they reach 15 years of age and are over 4 ft. (1.3 m.) in length. The actual historical and current distribution of where this species spawns is unclear because green sturgeon make non-spawning movements into coastal lagoons and bays in the late summer to fall, and because their original spawning distribution may have been reduced due to harvest and other anthropogenic effects (Adams et al. 2007). Green sturgeon spawn in the Rogue River, Klamath River Basin, the Sacramento River, and possibly in a few other tributaries along the West Coast. Green sturgeon are not known to spawn in Washington rivers, but they may occur in Puget Sound and its estuaries (Adams et al. 2007).

On October 9, 2009 NMFS designated critical habitat for the green sturgeon (74 FR 52300). The critical habitat designation includes the CCRA, PSRA and LCRRA. A principal factor in the decline of the Southern DPS of green sturgeon is the reduction of their spawning area to a limited portion of the Sacramento River. Other likely threats to green sturgeon are: insufficient freshwater flow rates in spawning areas, contaminants such as pesticides, bycatch in fisheries, potential poaching for caviar, introduction of exotic species, small population size, impassable barriers, and elevated water temperatures (NMFS 2012a).

Pacific eulachon/smelt

The Pacific eulachon (*Thaleichthys pacificus*) is a smelt species found in the eastern Pacific Ocean, ranging from northern California to southwest Alaska and into the southeastern Bering Sea. Eulachon are anadromous, spawning in freshwater systems and spending their juvenile and adult lives in marine waters. They are also very important ecologically, providing a food source for a wide variety of organisms such as birds, marine mammals, and fish in both marine and freshwater ecosystems (WDFW 2001). Although eulachon range from northern California to western Alaska, the southern DPS of eulachon consists of populations spawning in rivers south of the Nass River in British Columbia, Canada, to, and including, the Mad River in California (74 FR 10857). The largest historical production areas have been the Columbia and Fraser rivers, and possibly the Klamath River (Gustafson et al. 2010). Other areas where eulachon have been documented include the Rogue River and Umpqua Rivers in Oregon and infrequently in coastal rivers and tributaries to Puget Sound, Washington. The Fraser River is a key production area for eulachon that inhabit Puget Sound. Sizes of Fraser eulachon range from about 0.79 to 2.0 inches (20 to 50 millimeters) for age 0+ to about 5.3 to 6.3 inches (135 to 160 millimeters) for age 4+ fish (74 FR 10857). Based on historical landings data, the Columbia River supported more than 50% of total population abundance in the southern DPS area (Gustafson et al. 2010). Commercial harvests of eulachon in the Columbia River declined from approximately 500 metric tons during 1915-1992 to less than 5 metric tons in 2005-2008. The Fraser River population has also declined sharply. In March 2010, NMFS listed the southern DPS of Pacific eulachon as threatened (75 FR 13012).

Typically, eulachon typically spend 3 to 5 years in nearshore marine waters and up to 1,000 feet (305 meters) in depth, except for the brief spawning runs into their natal streams from late winter through early summer. During spawning, eulachon eggs are fertilized in the water column and after fertilization the eggs sink and adhere to the gravel and coarse sand river bottoms. Most eulachon adults die after spawning and eulachon eggs hatch in 20 to 40 days. After hatching, the larvae are then carried downstream and are dispersed by estuarine and ocean currents. Juvenile eulachon move from shallow nearshore areas to mid-depth areas (WDFW 2001).

NMFS issued a final rule to designate critical habitat for the southern DPS of Pacific eulachon (*Thaleichthys pacificus*) on October 20, 2011 (50 CFR 65324). Ten critical habitat areas were designated in Washington State, with most being tributaries of the Columbia River. Critical habitat has not been designated in Puget Sound. (NMFS 2012a). Habitat loss and degradation threaten the eulachon, particularly in the Columbia River basin, where most of the eulachon in the continental U.S. originate. The primary factor responsible for the decline of the southern DPS is climate change and its effects on ocean conditions and freshwater hydrology and other environmental factors. Directed commercial fishing for eulachon was identified as a low to moderate threat, whereas by catch in other commercial fisheries (e.g., shrimp) was a moderate threat to the species. Dams and water diversions are considered moderate threats. Eulachon presence in Puget Sound is rare.

Yelloweye rockfish

The yelloweye rockfish (*Sebastes ruberrimus*) is a listed species that ranges from northern Baja California to the Aleutian Islands in Alaska, but are most commonly observed from central California northward to the Gulf of Alaska. The yelloweye rockfish is comprised of two DPSs: coastal and Puget Sound/Georgia Basin. The Puget Sound/Georgia Basin Yelloweye Rockfish DPS was listed as threatened under the ESA in 2010 due to an absence of the species during surveys and uncertainty over the population levels within this region. Critical habitat was recently designated for several rockfish species in Puget Sound, including this DPS of yelloweye rockfish (79 FR 68042, November, 14, 2014).

As adult yelloweye rockfish mature and increase in size, they generally move into deeper waters and exhibit strong site fidelity to rocky bottoms and outcroppings. Yelloweye rockfish are among the longest lived marine fish of any species, with reports of specimens aged at more than 110 years. Various

restrictions have been placed on the fishing industry to assist in the recovery of this threatened species. Yelloweye rockfish are fished directly and are often caught as bycatch in other fisheries, including salmon fisheries (NMFS 2012a). DeLacy et al. (1972) and Miller and Borton (1980) discovered 113 documented yelloweye rockfish historical records from Puget Sound associated with sport catch. Due to a recent commercial and sport fishing moratorium in Puget Sound, data is not readily available on population levels and distribution within the waters of Puget Sound.

Salmonids

NOAA Fisheries has listed 30 species of salmonids on the West Coast, shown in Table 3.2-1. Included are two species of bull trout and 28 species of Pacific salmon and steelhead. All 28 ESUs and DPSs of Pacific salmon and steelhead are defined as naturally spawning but due to historical utilization of fish hatcheries to augment wild populations, 23 of them are defined to include a hatchery component as well. On April, 14, 2014 NMFS announced a revision to the Code of Federal Regulations (CFR) to clarify and update the descriptions of Pacific salmon and steelhead species that are currently listed as threatened or endangered under the Endangered Species Act of 1973 (ESA) (79 FR 20802). Revisions were based on recently completed 5-year reviews under ESA section 4(c)(2) and include updates to hatchery programs associated with each ESU or DPS. In addition to the 30 listed species, NMFS monitor three additional Chinook, coho, and steelhead species that are identified as SOCs. Table 3.2-1 shows the salmonid species currently listed under the ESA.

Bull trout

Bull trout (*Salvelinus confluentus*) is a threatened species with scattered populations found in portions of Washington, Oregon, Idaho, Nevada, Montana and western Canada. The bull trout also has two distinct population segments (DPS) within the CCRA; both the Columbia River DPS and Puget Sound/Coastal DPS are listed as threatened. The Coastal-Puget Sound Bull Trout DPS was listed on November 1, 1999 as threatened under ESA by the USFWS. This DPS encompasses bull trout living within the Puget Sound, as well as specimens residing in the rivers and streams that flow into this water body. The Columbia River bull trout (*Salvelinus confluentus*) DPS occurs throughout the entire Columbia River Basin within the United States and its tributaries, (USFWS 2010). Bull trout populations occur below the Bonneville Dam in two drainages: the Lewis River and the Willamette River (USFWS 2010). Individual bull trout are occasionally present in the mainstem Columbia River, but any extensive use has not been documented.

Bull trout are known to occur within many of the drainages within the greater Puget Sound and Olympic Peninsula but they typically prefer colder water temperatures, which are usually associated with snowmelt-fed streams. Spawning populations of bull trout are limited in western Washington to streams draining from perennial snowfields in the Cascade and Olympic Mountains. Anadromous bull trout have been documented to avoid deeper marine habitat beyond the photic zone. Although adult and sub-adult bull trout utilize Puget Sound nearshore habitat for foraging, their distribution appears to be limited by the distance they are able to migrate from their natal or over-wintering streams (Goetz 2004).

Bull trout prefer the upper reaches of cold, clear running streams with clean gravel and cobble substrate for spawning. Bull trout are not known to spawn within the mainstem Columbia River but are occasionally observed in the mainstem Columbia River (CRC 2011). Bull trout typically emerge from spawning gravel in April or May and are opportunistic feeders. Small bull trout eat terrestrial and aquatic insects but shift to preying on other fish as they grow larger. Adult bull trout prey on whitefish, sculpins, and other trout as they grow larger. Bull trout may be migratory or resident types, and adult bull trout may be found in the Columbia River between April and September (CRC 2011). Bull trout exhibit resident and migratory life-history strategies through much of their current range (Rieman and McIntyre 1993). Resident bull trout complete their life cycles in the tributary streams in which they spawn and rear.

Migratory bull trout spawn in tributary streams from August to November. Juvenile bull trout rear for one to four years before migrating to either a lake, river, or to saltwater.

On September 30, 2010, the U.S. Fish and Wildlife Service (USFWS) designated critical habitat for bull trout in 754 miles of marine shoreline within Washington State and in the Columbia River estuary downstream of Bonneville Dam (75 FR 2270 2431) (USFWS 2010). This designation was the result of an extensive review of the Service's previous bull trout critical habitat proposals and designation. The lower Columbia River estuary and Puget Sound are considered critical habitat for bull trout based on its importance as forage, migration, and overwintering habitat (USFWS 2010).

Chinook salmon

Chinook salmon (*Oncorhynchus tshawytscha*) are one of several species of salmon that have some evolutionarily significant units (ESUs) listed as endangered. Many other ESUs are not ESA-listed and are generally abundant. NMFS announced a revision to the Code of Federal Regulations (CFR) to clarify and update the descriptions of Chinook and other salmon species listings under the Endangered Species Act of 1973 (ESA) (79 FR 20802). Of the 18 recognized ESUs, three ESUs are listed as endangered, six are listed as threatened and two are listed as SOC (Table 3.2-1). In the U.S., Chinook salmon are found in rivers near the Bering Strait off Alaska's coast, south to the Ventura River in Southern California. The southern end of marine distribution expands and contracts seasonally and between years depending on ocean temperature patterns. Chinook salmon are an anadromous species of fish that spawn in freshwater rivers and streams and mature in the ocean. Juvenile Chinook may spend from three months up to two years in freshwater before migrating to estuarine areas as smolts, and then to the ocean to feed and mature. Smolts (juveniles that have transitioned from fresh water to salt water) usually migrate to estuarine areas within the first year, approximately 3 months after emergence from spawning gravel. This generally occurs April through July, (with some populational and emergence timing variability). Juvenile Chinook salmon occur in nearshore areas in Puget Sound and Columbia River Estuary from April to September with peak numbers in June (Fresh et al. 2006, Brennan et al. 2004). Juvenile Chinook remain in or near nearshore waters until they reach about four inches in length, and then they move out into deeper subtidal habitat and open coastal waters by mid-July (Cramer et al. 1999). Preferred nearshore habitats for juvenile Chinook salmon rearing in nearshore marine waters are tidal channels and vegetated areas at depths of less than 6.5 feet (2 meters). All listed chinook salmon ESUs include fish from hatchery programs except the California Coastal ESU.

Critical habitat has been designated for the nine listed ESUs of Chinook salmon: California coastal, Central Valley spring-run, lower Colombia River, upper Colombia River spring-run, Puget Sound, Sacramento River winter-run, Snake River fall-run, Snake River spring/summer-run, and upper Willamette River (NMFS 2012a). Critical habitat in Puget Sound and Columbia River Estuary is defined as the photic zone in all nearshore habitat, extending from extreme high water out to a depth of 98 feet (30 meters).

Chum salmon

Chum salmon (*Oncorhynchus keta*) exhibit a wide geographic and spawning distribution and their range extends from the shores of the Arctic Ocean to as far south as Tillamook Bay on the northern Oregon coast. The Columbia River ESU and Hood Canal summer-run ESU have been designated as threatened on March 25, 1999 (64 FR 14508) under the ESA (Table 3.2-1). These ESUs include all naturally spawned populations of chum salmon in the Columbia River and Hood Canal and their tributaries in Washington and Oregon. Historically, the Columbia River supported large numbers of chum salmon, and they may have spawned as far upstream as the Walla Walla River. Only a remnant population exists in the lower Columbia River, where they are few in number, low in abundance, and of uncertain stocking history. The Columbia River ESU is currently estimated to be less than 1 percent of historic levels (NMFS 2007a).

Chum salmon spawning migration occurs from October to December with a peak in mid-November. Juvenile chum salmon outmigration occurs between late-January and May, with a peak occurring in April. In general, chum salmon spawn in shallow, low gradient, low-velocity streams and side channels that are located in the lowermost reaches of rivers and streams, typically within 62 mi. (100 km.) of the ocean, often near springs. Fry typically emerge from the gravel at night and immediately out-migrate downstream from late January through May to forage in estuaries and nearshore waters. Juveniles begin to leave estuaries and move offshore as prey resources decline as they become big enough to feed on the larger neritic plankton (Salo 1991). This means that the survival and growth of juvenile chum salmon depends less on freshwater conditions and more on favorable estuarine and marine conditions. Chum salmon typically reach maturity at three years. All listed chum salmon ESUs include fish from hatchery programs.

In September 2005, critical habitat was designated for the threatened Columbia River ESU and Hood Canal summer-run ESU (NMFS 2007a).

Coho salmon

Coho salmon (*Oncorhynchus kisutch*) are an anadromous salmonid that were historically distributed throughout the North Pacific Ocean from central California to Point Hope, Alaska, through the Aleutian Islands. It is probable that coho salmon inhabited most coastal streams in Washington, Oregon, and central and northern California. NOAA Fisheries has identified four listed coho salmon ESUs; one (central California Coast ESU) is endangered and three (lower Columbia River ESU, Oregon Coast ESU and southern Oregon & northern California Coast ESU) are threatened (Table 3.2-1). The lower Columbia River evolutionarily significant unit (ESU) was listed as Threatened on June 28, 2005, includes naturally spawned coho salmon originating from the Columbia River and its tributaries downstream from the Big White Salmon and Hood Rivers (inclusive) and any such fish originating from the Willamette River and its tributaries below Willamette Falls. On April, 14, 2014 NMFS announced a revision to the Code of Federal Regulations (CFR) to clarify and update the descriptions of coho and salmon listings under the Endangered Species Act of 1973 (ESA) (79 FR 20802).

Adults migrate into freshwater to spawn between August and December with peak migration occurring in October. Coho salmon spawn from November to January. Habitat requirements include cool, oxygen-rich water and clean gravel. Eggs incubate in gravel interstices until spring. Coho juveniles spend the first half of their life cycle rearing and feeding in streams and small freshwater tributaries. Optimum rearing habitat consists of a mixture of pools and riffles, cover, low amounts of sedimentation, and cool temperatures. Typically, juveniles rear for 12 to 18 months in low-velocity side channels and other backwater areas with extensive cover before migrating to saltwater in spring or early summer. Coho salmon typically spend one to two years foraging in estuarine and marine waters of the Pacific Ocean before returning to their natal streams to spawn. All listed coho salmon ESUs include fish from hatchery programs.

Critical habitat was designated in May of 1999 for the Central California Coast and Southern Oregon/Northern California Coast ESUs, and in February 2008 for Oregon Coast ESU. On January 14, 2013, the NMFS proposed a rule to designate critical habitat for lower Columbia River ESU coho (78 FR 2726) (NMFS 2013a).

Sockeye salmon

Sockeye salmon (*Oncorhynchus nerka*) inhabit riverine, marine, and lake environments. Historical distribution in the U.S. may have included the Klamath River and its tributaries north and west, north to the Kuskokwim River in western Alaska. The Ozette Lake ESU is listed as threatened and the Snake River ESU is listed as endangered under ESA (Table 3.2-1). With the exception of certain river-type populations of sockeye, the vast majority of sockeye salmon spawn in or near lakes, where the juveniles rear for one to three years prior to migrating to sea. Sockeye salmon are primarily anadromous, although

there are distinct resident land-locked populations termed kokanee salmon, which mature, spawn, and die in fresh water. As sockeye generally require lakes for a portion of their life cycle, their distribution in river systems depends on the presence of nursery lakes in the system; therefore, their distribution and abundance may be more limited than for other Pacific salmon. Both listed sockeye salmon ESUs include fish from hatchery programs. Critical habitat was designated for the endangered Snake River ESU in December of 1993 and for the threatened Ozette Lake ESU in September, 2005 (NMFS 2014a).

Steelhead trout

Steelhead trout (*Oncorhynchus mykiss*) occur along the entire U.S. Pacific Coast from Mexico to the Copper River drainage in southcentral Alaska. *O. mykiss* can be anadromous (referred to as steelhead) or freshwater residents (referred to as rainbow trout), and, under some circumstances, can yield offspring of the alternate life history form (72 FR 26722). There are 15 recognized steelhead Distinct Population Segments (DPSs), which only include naturally spawned anadromous steelhead originating below natural and manmade impassable barriers. NMFS has concluded that, given the generally marked separation between the anadromous populations and resident life-history forms in physical, physiological, ecological, and behavioral factors, the anadromous steelhead populations are distinct from the resident rainbow trout populations within the DPSs area (NMFS and USFWS 2006). Consequently, the non-anadromous form, the rainbow trout, is not included in these DPSs. One steelhead DPS (Southern California) is listed as endangered and 10 are listed as threatened (Table 3.2-1).

All *O. mykiss* hatch in gravel-bottomed, fast-flowing, well-oxygenated rivers and streams. Adult steelhead migrate from the marine environment to their natal freshwater streams and rivers in order to spawn, while rainbow trout remain freshwater residents. Steelhead can spend up to 7 years in fresh water prior to smoltification and then spend up to 3 years in salt water prior to migrating back to their natal streams to spawn (Busby et al. 1996). In addition, steelhead may spawn more than once during their life span, whereas other Pacific salmon species generally spawn once and die. North American populations of steelhead tend to migrate through estuaries and quickly leave coastal waters soon after entering the ocean (Quinn 2005). During one purse seine survey conducted off Washington and Oregon, juvenile steelhead were almost exclusively encountered in the earliest (May-June) survey period, indicating this species did not linger in near coastal areas (Miller et al. 1983).

Although steelhead may occur in the nearshore waters of Puget Sound, they are generally not foraging and are essentially transient individuals migrating between their natal streams and the Pacific Ocean. Steelhead smolts usually migrate downstream to Puget Sound from April through June (Busby et al. 1996) and appear to spend little time in estuaries (Emmett et al. 1991). They appear to have little preference for nearshore habitat type during their migration through Puget Sound and are seldom caught as juveniles during beach seine studies of the nearshore (Fresh et al. 2006, Brennan et al. 2004).

Similar to Puget Sound, the lower Columbia River estuary is used primarily as a migration corridor for steelhead trout, since conditions within the lower Columbia River estuary are not suitable for steelhead spawning or rearing. Most steelhead in the Columbia River are anadromous and have similar life histories to stream-type salmon, with a multi-year fresh water period, followed by an ocean migration and residency, and a return to freshwater to spawn. There are two life histories of steelhead in the Columbia River basin: summer run fish and winter run fish. Summer run fish enter fresh water as immature adults between May and October. Winter run fish enter fresh water as mature adults between November and April. Juvenile steelhead may spend up to 7 years in fresh water before migrating to estuarine areas as smolts and then into the ocean to feed and mature. Lower Columbia River DPS juveniles could be in lower river from February to November. The Snake River DPS, Middle Columbia River DPS, Upper Columbia River DPS, and Upper Willamette DPS could be migrating through the lower river from March through June. Overall, juvenile steelhead could be migrating through the lower river between February and November. The adult summer-run migration occurs from May to November with the winter run

occurring from December to April for the Washington tributaries below the Bonneville Dam. All listed steelhead DPSs include fish from hatchery programs except Northern California, South Central California Coast, Southern California, and Upper Willamette Valley.

Critical habitat for 10 U.S. West Coast steelhead DPSs was designated in September of 2005 and includes Central California Coast, Southern California, Northern California, South Central California Coast, California Central Valley, Upper Columbia River, Snake River Basin, Lower Columbia River, Upper Willamette River and Middle Columbia River. On January 14, 2013, the NMFS proposed a rule to designate critical habitat for Puget Sound steelhead (78 FR 2726). The proposed critical habitat areas are all in freshwater drainages in Puget Sound, which are juvenile rearing and outmigration. NMFS is expected to make a final ruling on critical habitat designation soon.

Unlisted salmonids

There are also 21 other Pacific salmon and steelhead species that, based on scientific evaluation, are not listed because the populations stand at healthy levels. They are:

Chinook Salmon

- Upper Klamath-Trinity Rivers ESU
- Oregon Coast ESU
- Washington Coast ESU
- Middle Columbia River spring-run ESU
- Upper Columbia River summer/fall-run ESU
- Southern Oregon and Northern California Coast ESU
- Deschutes River summer/fall-run ESU

Chum Salmon

- Puget Sound/Strait of Georgia ESU
- Pacific Coast ESU

Coho Salmon

- Southwest Washington ESU
- Olympic Peninsula ESU

Pink Salmon

- Even-year ESU
- Odd-year ESU

Sockeye Salmon

- Baker River ESU
- Okanogan River ESU
- Lake Wenatchee ESU

- Quinalt Lake ESU
- Lake Pleasant ESU

Steelhead

- Southwest Washington DPS
- Olympic Peninsula DPS
- Klamath Mountains Province DPS

3.2.1.2 Target Species

Target species are those fish which are managed under an FMP, commercially or recreationally fished, and for which stock assessments are conducted using NWFSC fisheries research. For the purposes of this PEA, only those species that have had an average research catch of over 1 mt per year over the last five years, and are included in a Fishery Management Plan, are listed in Table 3.2-2. For information on life history traits and habitat for each of the species, please see the Pacific Fishery Management Council's website: <http://www.pcouncil.org>.

The majority of fish collected by the NWFSC research surveys were captured by only a few surveys:

- Groundfish Bottom Trawl Surveys (CCRA);
- Bycatch Reduction Bottom Trawl Surveys (CCRA);
- Hake Acoustic Surveys (Bottom Trawl) (CCRA);
- Juvenile salmon PNW Coastal Surveys (PSRA);
- Northern juvenile rockfish surveys (PSRA);
- PNW Piscine Predator & Forage Fish Surveys (PSRA);
- Near Coastal Purse Seining Surveys (PSRA);
- Puget Sound Marine Pelagic Foodweb Surveys (PSRA); and
- Columbia River Estuary Purse Seining (LCRRA).

Table 3.2-2 Commercially Fished Target Species in the NWFSC Research Areas.

Species	Scientific Name	Stock Status ¹	Fishery Management Council	Fishery Management Plan (FMP)
Arrowtooth flounder	<i>Atheresthes stomias</i>	Not overfished	PFMC	Pacific Coast Groundfish FMP
Aurora rockfish	<i>Sebastes aurora</i>	Not overfished	PFMC	Pacific Coast Groundfish FMP
Big skate	<i>Raja binoculata</i>	Monitored as ecosystem component	PFMC	Pacific Coast Groundfish FMP
Bocaccio, Southern Pacific Coast DPS	<i>Sebastes paucispinis</i>	Not overfished--rebuilding	PFMC	Pacific Coast Groundfish FMP

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Species	Scientific Name	Stock Status ¹	Fishery Management Council	Fishery Management Plan (FMP)
Canary rockfish, Pacific Coast stock	<i>Sebastes pinniger</i>	No overfishing, overfished	PFMC	Pacific Coast Groundfish FMP
Chilipepper, Southern Pacific Coast stock	<i>Sebastes goodei</i>	Not overfished	PFMC	Pacific Coast Groundfish FMP
Darkblotched rockfish, Pacific Coast stock	<i>Sebastes crameri</i>	No overfishing - rebuilding	PFMC	Pacific Coast Groundfish FMP
Dover sole	<i>Microstomus pacificus</i>	Not overfished	PFMC	Pacific Coast Groundfish FMP
English sole	<i>Parophrys vetulus</i>	Not overfished	PFMC	Pacific Coast Groundfish FMP
Greenstriped rockfish	<i>Sebastes elongatus</i>	No overfishing, overfished status unknown	PFMC	Pacific Coast Groundfish FMP
Halfbanded rockfish	<i>Sebastes semicinctus</i>	Unknown	PFMC	Pacific Coast Groundfish FMP
Lingcod	<i>Ophiodon elongatus</i>	Not overfished	PFMC	Pacific Coast Groundfish FMP
Longnose skate	<i>Raja rhina</i>	Not overfished	PFMC	Pacific Coast Groundfish FMP
Longspine thornyhead	<i>Sebastolobus altivelis</i>	Not overfished	PFMC	Pacific Coast Groundfish FMP
Northern anchovy	<i>Engraulis mordax</i>	Unknown	PFMC	Coastal Pelagic Species FMP
Pacific cod, Pacific Coast stock	<i>Gadus macrocephalus</i>	No overfishing, overfished status unknown	PFMC	Pacific Coast Groundfish FMP
Pacific grenadier	<i>Coryphaenoides acrolepis</i>	Unknown	PFMC	Pacific Coast Groundfish FMP
Pacific hake	<i>Merluccius productus</i>	Not overfished	PFMC	Pacific Coast Groundfish FMP and International Agreement
Pacific halibut	<i>Hippoglossus stenolepis</i>	Overfishing undefined, not overfished	Managed by International Pacific Halibut Commission	Managed by International Agreement
Pacific herring	<i>Clupea pallasii</i>	Monitored as ecosystem component	PFMC	Coastal Pelagic Species FMP
Pacific ocean perch	<i>Sebastes alutus</i>	No overfishing, overfished	PFMC	Pacific Coast Groundfish FMP
Pacific sanddab	<i>Citharichthys sordidus</i>	Overfishing unknown, not overfished	PFMC	Pacific Coast Groundfish FMP
Pacific sardine	<i>Sardinops sagax caerulea</i>	Not overfished	PFMC	Coastal Pelagic Species FMP
Petrale sole	<i>Eopsetta jordani</i>	Not overfished, rebuilding	PFMC	Pacific Coast Groundfish FMP

Species	Scientific Name	Stock Status ¹	Fishery Management Council	Fishery Management Plan (FMP)
Redstripe rockfish	<i>Sebastes proriger</i>	No overfishing, overfished status unknown	PFMC	Pacific Coast Groundfish FMP
Rex sole	<i>Glyptocephalus zachirus</i>	Overfishing unknown, not overfished	PFMC	Pacific Coast Groundfish FMP
Rosethorn rockfish	<i>Sebastes helvomaculatus</i>	No overfishing, overfished status unknown	PFMC	Pacific Coast Groundfish FMP
Rougeye rockfish	<i>Sebastes aleutianus</i>	Overfishing unknown, not overfished	PFMC	Pacific Coast Groundfish FMP
Sablefish	<i>Anoplopoma fimbria</i>	Not overfished	PFMC	Pacific Coast Groundfish FMP
Sharpchin rockfish	<i>Sebastes zacentrus</i>	Overfishing unknown, not overfished	PFMC	Pacific Coast Groundfish FMP
Shortbelly rockfish	<i>Sebastes jordani</i>	Not overfished	PFMC	Pacific Coast Groundfish FMP
Shortspine thornyhead	<i>Sebastolobus alascanus</i>	Not overfished	PFMC	Pacific Coast Groundfish FMP
Spiny dogfish	<i>Squalus acanthias</i>	Overfishing unknown, not overfished	PFMC	Pacific Coast Groundfish FMP
Splitnose rockfish	<i>Sebastes diploproa</i>	Not overfished	PFMC	Pacific Coast Groundfish FMP
Spotted ratfish	<i>Hydrolagus coliei</i>	No overfishing, overfished status unknown	PFMC	Pacific Coast Groundfish FMP
Stripetail rockfish	<i>Sebastes saxicola</i>	Overfishing unknown, not overfished	PFMC	Pacific Coast Groundfish FMP
Vermilion rockfish	<i>Sebastes miniatus</i>	Unknown	PFMC	Pacific Coast Groundfish FMP
Widow rockfish	<i>Sebastes entomelas</i>	Not overfished	PFMC	Pacific Coast Groundfish FMP
Yellowtail rockfish	<i>Sebastes flavidus</i>	Not overfished	PFMC	Pacific Coast Groundfish FMP

¹ Stock status information is from NMFS Sustainable Fisheries website for 2014, third quarter:
http://www.nmfs.noaa.gov/sfa/fisheries_eco/status_of_fisheries/archive/2014/third/q3_stock_status_tables.pdf

3.2.1.3 Other Fish Species

Hundreds of fish species have been caught during the course of NWFSC research that may not be subject to formal stock assessments or belong to one of the categories above. Non-managed commercial species include smelt species and Pacific herring. Non-commercial species captured in the CCRA that had an average catch of over 1 mt per year in NWFSC surveys during 2008-2012 include; giant grenadier, salmon shark, brown cat shark, lanternfish and Pacific sleeper shark. No commercial catch data was available on the NOAA commercial landings site for Puget Sound fisheries. Non-managed commercial

species captured in the PSRA include smelt species and Pacific herring. Non-commercial species captured include Pacific sand lance, peamouth, Pacific tomcod, threespine stickleback, staghorn sculpin, shiner perch, gunnel species, and tubesnout. Commercial catch data was available on the ODFW commercial landings site for lower Columbia River fisheries. Non-managed commercial species in the LCRRA include several smelt species and Pacific herring. Non-commercial species captured include common carp, banded killifish, American shad, chiselmouth, yellow perch, largescale sucker, northern pikeminnow, Pacific sand lance, peamouth, threespine stickleback, staghorn sculpin, striped shiner perch, and golden shiners.

3.2.2 Marine Mammals

The marine mammal species listed in Table 3.2-3 occur in the areas frequented by the NWFSC fisheries research surveys in the California Current (CCRA), Puget Sound (PSRA), and lower Columbia River (LCRRA) research areas. All marine mammals are federally protected under the U.S. Marine Mammal Protection Act (MMPA) of 1972. In addition, six species of whales occurring in the NWFSC research areas are listed as endangered, one pinniped and one fissiped species are listed as threatened under the ESA, and one stock of fur seals is considered depleted under the MMPA (Table 3.2-3). The survey areas also encompass designated critical habitat for two species. Threatened and endangered species encountered in the NWFSC survey areas are described in Section 3.2.2.2. Non-ESA listed marine mammals that have historically been taken during NWFSC research activities and those not historically taken but for which takes are requested by NWFSC in the LOA Application are described in section 3.2.2.3. Information provided here summarizes data on stock status, abundance, density, distribution and habitat, and auditory capabilities, as available in published literature and reports, including marine mammal stock assessments.

Table 3.2-3 Marine Mammal Species Encountered in the NWFSC California Current (CCRA), Puget Sound (PSRA), and Lower Columbia River (LCRRA) Research Areas.

Species		CCRA	PSRA	LCRRA	Federal ESA/ MMPA Status ¹
Common Name	Scientific Name				
CETACEANS					
Harbor porpoise	<i>Phocoena phocoena</i>				-
--Morro Bay stock		X			
--Monterey Bay stock		X			
--San Francisco-Russian River		X			
--Northern CA/Southern OR		X			
--Northern OR/WA coast		X		X	
--WA inland waters stock			X		
Dall's porpoise	<i>Phocoenoides dalli</i>	X	X		-
Pacific white-sided dolphin	<i>Lagenorhynchus obliquidens</i>	X	X		-
Risso's dolphin	<i>Grampus griseus</i>	X			-
Bottlenose dolphin	<i>Tursiops truncatus</i>				-
--CA coastal stock		X			

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Species		CCRA	PSRA	LCRRA	Federal ESA/ MMPA Status ¹
Common Name	Scientific Name				
--CA/OR/WA offshore		X			
Striped dolphin	<i>Stenella coeruleoalba</i>	X			-
Short-beaked common dolphin	<i>Delphinus delphis</i>	X			-
Long-beaked common dolphin	<i>Delphinus capensis</i>	X			-
Northern right whale dolphin	<i>Lissodelphis borealis</i>	X			-
Killer whale	<i>Orcinus orca</i>	X			-
--Eastern North Pacific --Southern Resident DPS		X	X		Endangered
-- Eastern North Pacific Northern Resident stock		X		X	
--Eastern North Pacific (West Coast) transient		X	X	X	-
--Eastern North Pacific offshore stock		X			-
Short-finned pilot whale	<i>Globicephala macrorhynchus</i>	X			-
Baird's beaked whale	<i>Berardius bairdii</i>	X			-
Mesoplodont beaked whales	<i>Mesoplodon spp.</i>	X			-
Cuvier's beaked whale	<i>Ziphius cavirostris</i>	X			-
Pygmy or Dwarf sperm whale	<i>Kogia breviceps</i> or <i>K. sima</i>	X			-
Sperm whale	<i>Physeter macrocephalus</i>	X			Endangered
Humpback whale	<i>Megaptera novaeangliae</i>	X	X ²		Endangered
Blue whale	<i>Balaenoptera musculus</i>	X			Endangered
Fin whale	<i>Balaenoptera physalus</i>	X			Endangered
Sei whale	<i>Balaenoptera borealis</i>	X			Endangered
Minke whale	<i>Balaenoptera acutorostrata</i>	X	X		-
Gray whale	<i>Eschrichtius robustus</i>				
--Eastern North Pacific stock		X	X		Delisted ³
--Western North Pacific stock ⁴		X			Endangered
PINNIPEDS					
California sea lion	<i>Zalophus californianus</i>	X	X	X	-
Steller sea lion --Eastern stock (DPS)	<i>Eumetopias jubatus monteriensis</i>	X	X	X	Delisted ⁵
Guadalupe fur seal	<i>Arctocephalus townsendi</i>	X			Threatened
Northern fur seal	<i>Callorhinus ursinus</i>				
--Eastern Pacific stock		X			Depleted
--California stock		X			-

Species		CCRA	PSRA	LCRRA	Federal ESA/ MMPA Status ¹
Common Name	Scientific Name				
Northern elephant seal	<i>Mirounga angustirostris</i>	X	X		-
Harbor seal	<i>Phoca vitulina richardsii</i>				-
--California stock		X			
--OR/WA coast stock		X		X	
--WA inland waters stocks ⁶			X		
FISSIPEDS					
Sea otter ⁷					
--Northern subspecies	<i>Enhydra lutris kenyoni</i>	X	X		
--Southern subspecies	<i>Enhydra lutris nereis</i>	X			Threatened

1. Denotes ESA listing as either endangered or threatened, or MMPA listing as depleted. By default, all species listed under the ESA as threatened or endangered are also considered depleted under the MMPA. All marine mammal stocks are considered protected under the MMPA.
2. The species is rare or uncommon, but seen on occasion.
3. The eastern North Pacific stock of gray whales was removed from the list of threatened and endangered species in 1994; the western North Pacific stock remains endangered.
4. The western North Pacific (WNP) stock of gray whales feeds in summer and fall in the Okhotsk Sea, Russia. Historically, wintering areas included waters off Korea, Japan, and China. Recent tagging, photo-identification, and genetics studies found some WNP gray whales migrate to the eastern North Pacific (ENP) in winter, including off Canada, the U.S., and Mexico (Lang et al. 2011, Mate et al. 2011, Weller et al. 2012, Urbán et al. 2013). Combined, these studies include 27 individual WNP gray whales in the ENP (Carretta et al. 2015).
5. In November 2013, NMFS issued a final rule to remove the eastern distinct population segment (DPS) of Steller sea lions from the List of Endangered and Threatened Wildlife (78 FR 66140, November 4, 2013).
6. Includes Hood Canal, Southern Puget Sound, and Washington northern inland waters stocks.
7. Sea otters are under the jurisdiction of the U.S. Fish and Wildlife Service.
7. The northern sea otter is listed as a state endangered species by Washington State; the southwestern DPS, which occurs in Alaska, is listed as threatened under the ESA.

3.2.2.1 Marine Mammal Acoustics and Hearing

Marine mammals rely on sound production and reception for social interactions (e.g., reproduction, communication), to find food, to navigate, and to respond to predators. General reviews of cetacean and pinniped sound production and hearing may be found in Richardson et al. (1995), Edds-Walton (1997), Wartzok and Ketten (1999), and Au and Hastings (2008). Several recent studies on hearing in individual species or species groups of odontocetes and pinnipeds also exist (e.g., Kastelein et al. 2009, Kastelein et al. 2013, Ruser et al. 2014). Interfering with these functions through anthropogenic noise could result in potential adverse impacts.

Southall et al. (2007) provided a comprehensive review of marine mammal acoustics including designating functional hearing groups. Assignment was based on behavioral psychophysics (the relationship between stimuli and responses to stimuli), evoked potential audiometry, auditory morphology, and, for pinnipeds, whether they were hearing through air or water. Since no direct measurements of hearing exist for baleen whales, hearing sensitivity was estimated from behavioral responses (or lack thereof) to sounds, commonly used vocalization frequencies, body size, ambient noise levels at common vocalization frequencies, and cochlear measurements. NOAA modified the functional hearing groups of Southall et al. (2007) to extend the upper range of low-frequency cetaceans and to divide pinnipeds into Phocids and Otariids (NOAA 2013b). Detailed descriptions of marine mammal auditory weighting functions and functional hearing groups are available in NOAA (2013b). Table 3.2-4

presents the functional hearing groups and representative species or taxonomic groups for each; most species found in the NWFSC project areas are in the first two groups, low frequency cetaceans (baleen whales) and mid frequency cetaceans (odontocetes).

Table 3.2-4 Summary of the Five Functional Hearing Groups of Marine Mammals^{1, 2}

Functional Hearing Group	Estimated Auditory Bandwidth	Species or Taxonomic Groups
Low Frequency Cetaceans (<i>Mysticetes—Baleen whales</i>)	7 Hz to 30 kHz (best hearing is generally below 1000 Hz, higher frequencies result from humpback whales)	All baleen whales
Mid- Frequency Cetaceans (<i>Odontocetes—Toothed whales</i>)	150 Hz to 160 kHz (best hearing is from approximately 10-120 kHz)	Includes species in the following genera: <i>Tursiops, Stenella, Delphinus, Lagenorhynchus, Lissodelphis, Grampus, Orcinus, Globicephala, Physeter, Ziphius, Berardius, Mesoplodon</i>
High-frequency Cetaceans (<i>Odontocetes</i>)	200 Hz to 180 kHz (best hearing is from approximately 10-150kHz)	Includes species in the following genera: <i>Phocoena, Phocoenoides, Kogia</i>
Phocid pinnipeds (<i>true seals</i>)	75 Hz to 100 kHz (best hearing is from approximately 1-30 kHz)	All seals
Otariid pinnipeds (<i>sea lions and fur seals</i>)	100 Hz to 40 kHz (best hearing is from approximately 1-16 kHz)	All fur seals and sea lions

1. Based on Southall et al. 2007, DON 2008, and NOAA 2013b

2. Southall et al. (2007) do not specifically address sea otters due to lack of available data.

3.2.2.2 Threatened and Endangered Marine Mammals

Species included in this section are only those listed as threatened or endangered under the ESA. Table 3.2-3, however, lists all marine mammal species encountered in the NWFSC California Current (CCRA), Puget Sound (PSRA), and lower Columbia River (LCRRA) research areas.

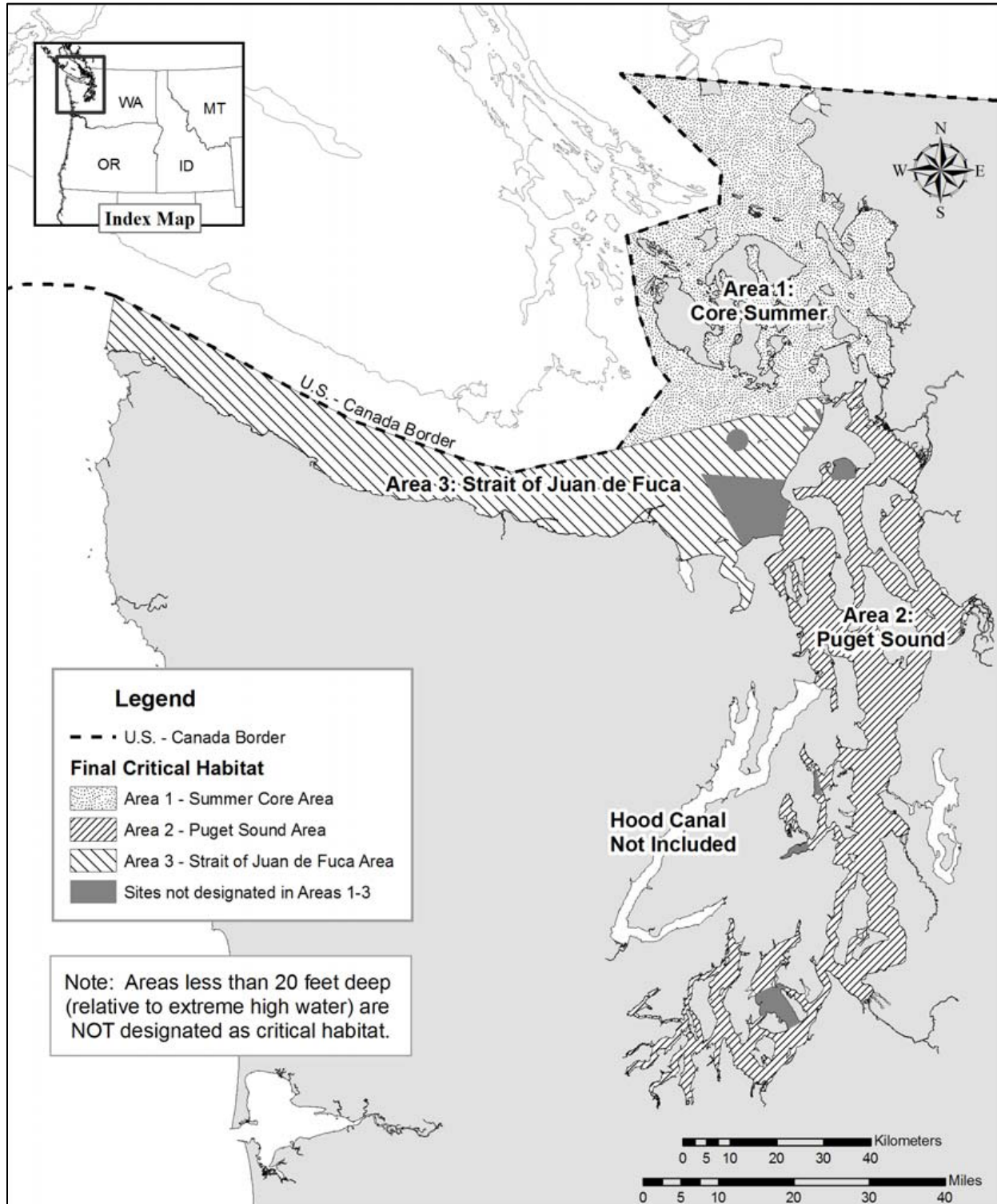
Killer whale: Eastern North Pacific Southern Resident DPS

Status and trends: In 2005, NMFS listed the Eastern North Pacific Southern Resident Killer Whale (SRKW) distinct population segment (DPS) as an endangered species under the ESA. Since the annual census presumably includes the entire population, best and minimum population estimates are the same and are equal to direct counts of individually identifiable whales. The most recent stock assessment estimate of 82 whales includes data through 2013 (Carretta et al. 2015). The population fluctuates over time and, as of March 2015, was estimated at 80 individuals, including three new calves (NWFSC 2015). The most recent PBR level for this stock (0.13 whales per year) is based on the minimum population size of 82 multiplied by one-half the default maximum net growth rate for cetaceans (half of 3.2 percent) and a recovery factor of 0.1. Total observed fishery mortality and serious injury for this stock is zero. Although there was one ship strike death in 2006, there were no non-fishery human-caused mortalities or serious injuries reported from 2008 to 2012. The total estimated annual human-caused mortality and serious injury for this stock is, therefore, zero and does not exceed PBR (Carretta et al. 2015).

None of the other stocks of killer whales that occur in NWFSC research areas (i.e., the Eastern North Pacific Northern Resident, Eastern North Pacific Transient, and Eastern North Pacific Offshore stocks) are listed under the ESA.

Distribution and habitat preferences: Killer whales are found in all oceans and are second only to humans as the most widely dispersed of all mammals (Ford 2009). They frequent in highly productive coastal and temperate waters. The range of SRKWs during the spring, summer, and fall includes the inland waters of Puget Sound, Strait of Juan de Fuca, and Southern Georgia Strait. SRKWs typically stay within 200 miles of the San Juan Islands (Osborne et al. 1988). They also occur in coastal waters of Oregon, Washington, Vancouver Island, and, in recent years, off the central California coast and the Queen Charlotte Islands. SRKW have also been reported off the mouth of the Columbia River coincident to spring Chinook run (NMFS 2008b, Zamon et al. 2007). Killer whales may occasionally venture into the lower Columbia River, although it is not known if reports from the 1930s and 1940s of killer whales as far as 180 km upriver were of transient or resident killer whales (Shepard 1932 and Scheffer and Slipp 1948 as cited in NMFS 2008b). As summarized by Carretta et al. (2014), most sightings of the SRKW stock occur in the summer in inland waters of Washington and southern British Columbia. The farthest north SRKW have been documented is off Chatham Strait, Alaska in June 2007. The complete winter range of this stock is uncertain, although there are indications that animals travel as far south as Monterey, California and as far north as the north coast of British Columbia. Recent satellite tagging studies by NOAA and the Center for Whale Research on an adult male SRKW showed a southward migration to northern California coastal waters during the winter and a northward movement in March to waters off the mouth of the Columbia River (NOAA 2013c).

NMFS published a final rule designating critical habitat for Southern Resident killer whales on November 29, 2006 (71 FR 69054). The area includes approximately 2,560 mi² (6,630 km²) of marine habitat in Washington State (Figure 3.2-1). In August 2015, NMFS announced a 90-day finding on a petition to revise SRKW critical habitat to include waters along the U.S. West Coast, from Cape Flattery, WA to Point Reyes, CA, that constitute essential foraging and wintering areas (79 FR 22933, April 25, 2014). The petition also requests the adoption of protective in-water sound levels for current and proposed critical habitat. In February 2015, NMFS issued a 12-month finding on this petition, announcing their intent to proceed with the petitioned action to revise SRKW critical habitat. NMFS anticipates publishing a proposed rule in 2017 (80 FR 9682, February 24, 2015).



Source: NMFS 2008b

Figure 3.2-1 Designated Critical Habitat for Southern Resident Killer Whales

Behavior and life history: Killer whales are very social and the basic social unit is based on matriline relationship and linked by maternal decent. Females give birth when between 11 and 16 years of age with a 5-year interval between births. Gestation is 15-18 months and weaning is about 1-2 years after birth. Males attain sexual maturity at about 15 years of age. Life expectancy for females is about 50 years with a maximum of 80-90; males typically live to about 29 years of age (Ford 2009). Killer whales have no natural predators, but neonatal mortality is high with nearly 46% dying in the first 6 months (Ford 2009).

The SRKW DPS primarily feeds on salmon, especially Chinook salmon returning to rivers in Washington and southern British Columbia (Hanson et al. 2010). Resident killer whale pods in Puget Sound exhibit cooperative food searching but perhaps not food capture (Hoelzel 1993). Transient killer whales feed on seals, sea lions, and young or smaller cetaceans (Ford 2009) with an optimal group size of at least three whales needed to efficiently chase and capture marine mammal prey (Baird et al. 1992).

Sperm whale

Status and trends: Sperm whales are listed as endangered under the ESA, and consequently the California/Oregon/Washington stock is considered as a depleted and strategic stock under the MMPA. The most recent abundance estimates for sperm whales off California, Oregon, and Washington, out to 300 nm, derive from trend-model analysis of line-transect data collected during six surveys from 1991 to 2008. Using this method, estimates ranged from 2,000 to 3,000 animals (Moore and Barlow 2014). The best estimate for the California Current (2,106 sperm whales) is the trend-estimate that corresponds with the 2008 survey (Carretta et al. 2015). The minimum population estimate is 1,332 whales and the calculated PBR is 2.7 sperm whales per year (Carretta et al. 2015, Moore and Barlow 2014). The mean annual estimated mortality and serious injury attributable to commercial fisheries interactions was 1.7 sperm whales per year, based on observer and stranding data from 2001 to 2012. There were no documented mortalities or serious injuries of sperm whales due to ship strikes from 2008 to 2012. The annual fishery-related and ship strike mortality and serious-injury is less than PBR, but greater than ten percent of PBR, so cannot be considered insignificant and approaching a zero mortality and serious injury rate (Carretta et al. 2015).

Barlow and Forney (2007) estimated the density of sperm whales off California, Oregon, and Washington at 1.70 whales/1000 km².

Distribution and habitat preferences: As described by Carretta et al. (2013, and citations therein), populations of sperm whales exist in waters of the California Current Ecosystem throughout the year. They are distributed across the entire North Pacific and into the southern Bering Sea in summer but the majority are thought to be south of 40° N in winter. Sperm whales are found year round in California waters, but they reach peak abundance from April through mid-June and from the end of August through mid-November. Acoustic detections of sperm whales in the offshore waters of the outer Washington coast occurred all months of the year, with peak occurrence April to August. Detections inshore from April to November were generally faint enough to suggest that the whales were offshore (Oleson et al. 2009).

Behavior and life history: Females reach sexual maturity at about age 9 when roughly 9 m long and they give birth about every 5 years; gestation is 14-16 months (Whitehead 2009). Sperm whales consume numerous varieties of deep water fish and cephalopods.

Humpback whale

Status and trends: The humpback whale is listed as endangered under the ESA throughout its range. In the North Pacific, there are at least three separate populations, all of which migrate between specific summer/fall feeding areas and winter/spring calving and mating areas.

The California/Oregon/Washington stock spends the winter primarily in coastal waters of Mexico and Central America, and the summer along the West Coast from California to British Columbia. The Central

North Pacific stock primarily spends winters in Hawaii and summers in Alaska, and its distribution may partially overlap with that of the California/Oregon/Washington stock off the coast of Washington and British Columbia (Clapham 2009). The Western North Pacific stock spends winters near Japan and probably migrates to the Bering Sea and Aleutian Islands in summer. There is some mixing between these populations, though they are still considered distinct stocks. The California/Oregon/Washington stock and the Central North Pacific stocks occur in the NWFSC research areas. Humpbacks in northern Washington and southern British Columbia may be a distinct feeding population or stock (Calambokidis et al. 2008).

The current best estimate of 1,918 whales for the California/Oregon/Washington stock is the sum of recent abundance estimates for California/Oregon (1,729) and Washington/southern British Columbia (189) feeding groups (Carretta et al. 2014). The feeding aggregation off Washington was previously estimated to be approximately 500 animals, most of which occur in the northwest Washington-British Columbia border area; a small number are periodically seen within Puget Sound (Calambokidis et al. 2009). The minimum estimate for humpback whales in the California/Oregon/Washington population based on line-transect and mark-recapture methods is 1,876. The population was increasing at a rate of approximately 7.5 percent per year, but recent trends are more variable (Calambokidis and Barlow 2013, Carretta et al. 2014). The PBR level for this stock is calculated as the minimum population size (1,878) times one half the estimated population growth rate for this stock times a recovery factor of 0.3, resulting in a PBR of 22 whales. This stock spends approximately half its time outside the U.S. EEZ, so the PBR allocation for U.S. waters is 11 whales per year. The estimated annual mortality and serious injury due to entanglement (4.4/yr), other anthropogenic sources (zero), plus ship strikes (1.1/yr) in California is less than the PBR for U.S. waters. Annual mortality and serious injury in commercial fisheries is greater than 10% of the PBR, and is, therefore, not approaching a zero mortality and serious injury rate.

The minimum population estimate for the Central North Pacific stock of humpback whales, based on counts of unique individuals, is 7,890 whales. Using a maximum net productivity rate of 0.07 and a recovery factor of 0.3, the calculated PBR for this stock is 82.8 whales (Allen and Angliss 2014b). The minimum population estimate for the Southeast Alaska/northern British Columbia feeding aggregation component of the Central North Pacific stock is 2,251, with a PBR of 23.6 (Allen and Angliss 2014). The minimum estimated annual mortality and serious injury rate for the entire stock (14.52, with 0.75 commercial fishery-related entanglements in observed fisheries, 7.30 opportunistically-reported entanglements in fishing gear and marine debris in Alaska and Hawaii, and 4.57 opportunistically-reported vessel collisions in Alaska (2.14) and Hawaii (2.43)) does not exceed PBR for this stock. The minimum estimated U.S. commercial fishery-related mortality and serious injury in observed fisheries is less than 10% of PBR and, therefore, considered insignificant and approaching a zero mortality and serious injury rate (Allen and Angliss 2014b).

Barlow and Forney (2007) estimated the density of humpback whales off California, Oregon, and Washington at 0.83 whales/1000 km².

Distribution and habitat preferences: Humpback whales are found in all oceans of the world and migrate from high latitude feeding grounds to low latitude calving areas. They are typically found in coastal or shelf waters in summer and close to islands and reef systems in winter (Clapham 2009). Humpbacks primarily occur near the edge of the continental slope and deep submarine canyons, where upwelling concentrates zooplankton near the surface for feeding. They often feed in shipping lanes which makes them susceptible to mortality or injury from large ship strikes (Douglas et al. 2008).

The feeding aggregation off Washington occurs primarily in the northwest Washington-British Columbia border area; a small number are periodically seen within Puget Sound (Calambokidis et al. 2004, Calambokidis et al. 2009). Humpbacks were one of the most commonly sighted large whales in Washington Inland waters and Puget Sound in the early 1900s, but are only seen occasionally now (Calambokidis and Steiger 1990). Although uncommon, humpback sightings in the Strait of Georgia and Puget Sound increased during the early 2000s to include 13 individually identified whales (Falcone et al.

2005). Humpback whales also occur along the outer coast of Washington in waters greater than 50 m depth on the continental shelf (Oleson et al. 2009).

Behavior and life history: Humpback whales are known for their spectacular aerial behaviors and complex songs of males, the latter of which is presumably to attract females. They breed in warm tropical waters after an 11 month gestation period; calves feed independently after about 6 months. Humpback whales feed on euphausiids and various schooling fishes, including herring, capelin, sand lance, and mackerel (Clapham 2009).

Blue whale

Status and trends: Blue whales are listed as endangered under the ESA. The best estimate of blue whale abundance in the U.S. West Coast feeding stock component of the Eastern North Pacific stock is 1,647 for 2008 to 2011 (Calambokidis and Barlow 2013, Carretta et al 2014). Barlow and Forney (2007) estimated the density of blue whales off California, Oregon, and Washington at 1.36 whales/1000 km². The minimum population size is approximately 1,551 blue whales with a calculated PBR of 9.3 (Carretta et al. 2014). Because whales in this stock spend approximately three quarters of their time outside the U.S. EEZ, the PBR allocation for U.S. waters is one-quarter of this total, or 2.3 whales per year. The average annual incidental mortality and serious injury rate from ship strikes (1.9/year for 2007-2011) is less than the calculated PBR for this stock. This rate, however, does not include unidentified large whales struck by ships, so the actual number may exceed PBR. There have been no reported blue whale mortalities associated with commercial fisheries and the total fishery mortality and serious injury rate is approaching zero (Carretta et al. 2014).

Distribution and habitat preferences: The blue whale has a worldwide distribution in circumpolar and temperate waters. Seasonal migrations of blue whales are driven by food requirements. Pole-ward movements in spring allow the whales to take advantage of high zooplankton production in summer, while movement toward the subtropics in the fall allows blue whales to reduce their energy expenditure while fasting and to avoid ice entrapment. The Eastern North Pacific Stock of blue whales ranges from the northern Gulf of Alaska to the Eastern Tropical Pacific (Carretta et al. 2013). The only NWFSC research area in which blue whales is the CCRA. Most of this stock is believed to migrate south to spend the winter and spring in high productivity areas off Baja California, in the Gulf of California, and on the Costa Rica Dome (a large, 300-500 km², relatively stationary eddy centered near 9° N and 89° W).

Behavior and life history: Blue whales reach sexual maturity at 5-15 years of age; length at sexual maturity in the Northern Hemisphere for females is 21-23 m and for males it is 20-21 m (Sears and Perrin 2009). Females give birth about every 2-3 years in winter after a 10-12 month gestation; longevity is thought to be at least 80-90 years (Sears and Perrin 2009). Blue whales occur primarily in offshore deep waters (but sometimes near shore, e.g. the deep waters in Monterey Canyon, CA) and feed almost exclusively on euphausiids.

Fin whale

Status and trends: Fin whales are listed as endangered under the ESA, and consequently the California/Oregon/Washington stock is considered as a depleted and strategic stock under the MMPA. The best estimate of fin whale abundance in California, Oregon, and Washington waters out to 300 nmi is 3,051 whales for 2008, based on trend-model analysis of line-transect data from 1991 through 2008.. The minimum population estimate is 2,598 fin whales with a calculated PBR of 16 whales per year (Carretta et al. 2014). Barlow and Forney (2007) estimated the density of fin whales off California, Oregon, and Washington at 1.84 whales/1000 km². The total incidental mortality due to fisheries (0.6/yr) and ship strikes (1.6/yr) from 2007 to 2011 is less than the PBR. Total fishery mortality is less than 10% of PBR and the mortality and serious injury rate may be approaching zero (Carretta et al. 2014).

Distribution and habitat preferences: Fin whales are distributed widely in the world's oceans and occur in both the Northern and Southern Hemispheres between 20–75° latitude (DON 2008). In the northern hemisphere, they migrate from high Arctic feeding areas to low latitude breeding and calving areas. The North Pacific population summers from the Chukchi Sea to California, and winters from California southward. Fin whales occur year-round off California, Oregon, and Washington in the CCRA, with aggregations in southern and central California (Carretta et al. 2012 and citations therein). Association with the continental slope is common (Schorr et al. 2010).

Behavior and life history: Fin whales become sexually mature between six to ten years of age, and reproduction occurs primarily in the winter. Gestation lasts about 11 months and nursing occurs for 6 to 11 months (Aguilar 2009). Fin whales feed on planktonic crustaceans, including *Thysanoessa* sp. euphausiids and *Calanus* sp. copepods, and schooling fish, including herring, capelin and mackerel (Aguilar 2009).

Sei whale

Status and trends: The population structure and status of most stocks of sei whales are not well known. Population structure is assumed to be discrete by ocean basin (NMFS 2011a). Sei whales in the Eastern North Pacific (east of 180° W longitude) are considered a separate stock (Carretta et al. 2013).

Sei whales are listed as endangered under the ESA, and consequently the Eastern North Pacific stock is automatically considered as a depleted and strategic stock under the MMPA. The best estimate of abundance for California, Oregon, and Washington waters out to 300 nmi is 126 (CV=0.53) sei whales, the unweighted geometric mean of the 2005 and 2008 estimates (Barlow and Forney 2007, Forney 2007, Barlow 2010). Barlow and Forney (2007) estimated the density of sei whales off California, Oregon, and Washington at 0.09 whales/1000 km². The minimum population estimate is 83, with a calculated PBR of 0.17 sei whales per year. Total estimated fishery mortality is zero and therefore is approaching zero mortality and serious injury rate. One ship strike death was reported in Washington in 2003. Although sei whales may account for some of the unidentified large whales reportedly injured by ship strikes, the average observed mortality due to ship strikes was zero from 2004 to 2008 (Carretta et al. 2014).

Distribution and habitat preferences: Sei whales have a worldwide distribution, but are found primarily in cold temperate to subpolar latitudes rather than in the tropics or near the poles (Horwood 2009). They occur across the temperate North Pacific north of 40°N latitude, but rarely far into the Bering Sea (NMFS 2011a). Sei whales spend the summer months feeding in subpolar higher latitudes and return to lower latitudes to calve in the winter. There is some evidence from whaling catch data of differential migration patterns by reproductive class, with females arriving at and departing from feeding areas earlier than males. For the most part, the location of winter breeding areas is unknown (Horwood 2009).

Behavior and life history: Sei whales mature at about 10 years for both sexes. They are most often found in deep, oceanic waters of the cool temperate zone. They appear to prefer regions of steep bathymetric relief, such as the continental shelf break, canyons, or basins situated between banks and ledges. On feeding grounds, the distribution is largely associated with oceanic frontal systems (Horwood 2009). In the North Pacific, sei whales feed along the cold eastern currents (Perry et al. 1999). Prey includes calanoid copepods, krill, fish, and squid. The dominant food for sei whales off California during June through August is the northern anchovy, while in September and October they eat mainly krill.

Guadalupe fur seal

Status and trends: Guadalupe fur seals are listed as a threatened species under the ESA, and consequently their stocks are automatically considered as depleted and strategic under the MMPA. The state of California lists the Guadalupe fur seal as a fully protected mammal and it is also listed as a threatened species in the Fish and Game Commission California Code of Regulations. The population

was estimated by Gallo (1994) to be about 7,408 in 1993, derived by multiplying the number of pups (counted and estimated) by a factor of 4.0. The minimum size of the population in Mexico was estimated using the actual count of 3,028 hauled out seals. (Carretta et al. 2014). However, these data are now outdated (older than eight years), as the last abundance survey occurred in 1993. The minimum population estimate should, therefore, be considered unknown and the PBR, consequently, cannot be determined (NMFS 2005b). Information is insufficient to determine whether the fishery mortality in Mexico exceeds the previously calculated PBR of 91. There are no reports of mortality or serious injury of Guadalupe fur seals in the U.S. and information is not available for human-caused mortality or injuries in Mexico (Carretta et al. 2014).

Distribution and habitat preferences: Guadalupe fur seals pup and breed mainly at Isla Guadalupe, Mexico (Arnould 2009; Carretta et al. 2011 and citations therein). The population is considered to be a single stock because all individuals are recent descendants from one breeding colony at Isla Guadalupe, Mexico. Individuals have been sighted as far north as central California, and as far south as Zihuatanejo, Mexico. Guadalupe fur seals are seasonally present in low numbers in California waters.

Behavior and life history: Definitive data are lacking on life history of Guadalupe fur seals but most species in the genus reach sexual maturity at 3-5 years of age; males also mature at about the same age but are unable to attain reproductive status (obtain a reproductive territory) until 7-10 years of age. Guadalupe fur seals pup in June-July. Southern fur seals, including the Guadalupe fur seal, feed on a variety of prey including fish, cephalopods and crustaceans, depending on prey abundance and location. Most southern fur seals forage in upwelling zones, oceanic fronts, or continental shelf-edge regions (Arnould 2009). Specific foraging and dive information is not known for the Guadalupe fur seal. But other species in this genus forage mainly in the surface mixed layer (<50-60 m) at night (Arnould 2009).

Sea Otter: Southern and Northern Subspecies

Status and Trends: Three subspecies of sea otters are recognized: *E.l. lutris* (which occurs primarily in Russia), *E.l. kenyon*i (the Northern subspecies which occurs primarily in Alaska and Washington state), and *E.l. nereis* (the Southern subspecies which occurs in central California). The Southern subspecies of sea otters is listed as threatened under the ESA. Springtime range-wide counts of southern sea otters increased from 1,277 animals in 1983 to 2,941 animals in 2013; this includes periods of increasing, stable, and decreasing numbers. A three-year running average of the spring counts shows the population increasing from 2006 to 2008, decreasing from 2008 to 2010, and increasing again between 2010 and 2013. Although population growth since 2010 averaged 1.5 percent per year, the trend since 2006 is essentially flat (Carretta et al. 2014, USFWS 2012a). The calculated PBR for the southern sea otter is 8 animals. However, the take of southern sea otters incidental to commercial fishing operations cannot be authorized under the MMPA. Provisions governing such authorization, including requirements to develop take reduction plans to reduce incidental mortality or serious injury to levels less than the PBR, do not, therefore, apply to southern sea otters (Carretta et al. 2014). Several commercial fisheries could interact with sea otters, but lack of observer data precludes making determinations regarding levels of mortality and serious injury (Carretta et al. 2014).

Sea otters off Washington State are descended from the Amchitka Island sea otters and are, thus, related to the southwest Alaska distinct population segment recently listed as threatened under the ESA. They are, however, geographically isolated from the southwest Alaska population by hundreds of kilometers and are not included in the listing. Sea otters off the Washington coast have been listed as a Washington State endangered species since 1981 due to small population size, restricted distribution, and vulnerability (Lance et al. 2004). In Washington State, 65 sea otters were counted in 1985, increasing to 276 in 1991 (Jameson and Jeffries 2010). The total count for the 2014 survey was 1,573 sea otters, which is the minimum estimate that will be used to calculate PBR (Jeffries and Jameson 2015). Minimum estimates for the previous few years were 1,004, 1,154, 1,105, and 1,272 for 2010, 2011, 2012, and 2013

respectively. The rate of increase for the Washington sea otter population slowed somewhat from recent years, but remained positive at 7.6 percent since 1989 (Jeffries and Jameson 2015). Laidre et al. (2002) estimated the carrying capacity of sea otters in Washington at 1,836 individuals. The calculated PBR for the Washington stock of sea otters is 11 animals (Carretta et al. 2013). Some mortality and serious injury occurs through set-net fisheries interactions, but information is lacking to estimate mortality and serious injury from other fisheries or sources of human-caused mortality (Carretta et al. 2013).

Distribution and habitat preferences: Sea otters are non-migratory, full time residents in Pacific coastal areas. They rarely wander more than a few miles from their established feeding grounds (Kenyon 1981). Otters prefer a protected inshore area with a rocky bottom and an abundance of kelp (Riedman 1990a). The remnant population of southern sea otters occurs in central California and there is a small translocated colony on San Nicolas Island (USFWS 2012a). Sea otters in Washington range from the mouth of the Columbia River north to Cape Flattery and east to Tongue Point in the Strait of Juan de Fuca, although no sea otters were seen in the latter area in 2010 (Jameson and Jeffries 2010). In 2013, most (62 percent) of the Washington sea otter population was in the area south of La Push, 38 percent were north of that area, and only six sea otters were seen east of Cape Flattery in the Strait of Juan de Fuca on one of three survey days (Jeffries and Jameson 2014). Scattered sightings of generally one or two individual sea otters have been reported in the San Juan Islands and Puget Sound (Jeffries and Jameson 2014).

Behavior and life history: Sea otters pup in late winter and early spring, and the pups are weaned in late summer and early fall. They forage on a variety of marine invertebrates, including sea urchins, throughout the entire depth range from intertidal areas out to at least 40 m (Estes et al. 2009). Feeding occurs both at day and night. Sea otters are preyed upon by white sharks, killer whales, and, infrequently, Steller sea lions.

3.2.2.3 Non-ESA Listed Marine Mammals that could be taken during the course of NWFSC research activities.

Species included in this section are non-ESA listed species that could be taken by mortality/serious injury or 'Level A' harassment during the course of NWFSC fisheries research over the next five years. This includes species that have historically (1999-2014) been taken, those with vulnerabilities similar to those previously taken and could, therefore, be taken in the future, and species that have been taken by commercial fisheries using gear analogous to that used during fisheries research. Species historically taken include Pacific white-sided dolphins, California sea lions, Steller sea lions, northern fur seals, and harbor seals. Detailed species descriptions and take determinations are available in the LOA Application (Appendix C) and in Table 4.2-8 of this DPEA.

Harbor porpoise

The six harbor porpoise stocks recognized within the NWFSC research areas are the Morro Bay, Monterey Bay, San Francisco-Russian River, Northern California-Southern Oregon, Northern Oregon/Washington coastal, and Washington inland waters stocks.

The estimated abundance of the Morro Bay stock, based on aerial surveys in 2012, is 2,917 animals. The minimum population estimate is 2,102 and the PBR is 21 animals (Carretta et al. 2014). There was one fishery-related mortality reported within this stock's range, for an annual average of ≥ 0.2 for 2007 to 2011 (Carretta et al. 2014).

The estimated abundance of the Monterey Bay stock, based on aerial surveys in 2011, is 3,715 animals. The minimum population estimate is 2,480 and the PBR is 25 animals (Carretta et al. 2014). There was no documented fishery-related mortality or injury within this stock's range from 2007 to 2011 (Carretta et al. 2014).

The estimated abundance of the San Francisco-Russian River stock, based on aerial surveys in 2007-2011, is 9,886 animals (Carretta et al. 2014). The minimum population estimate is 6,625 animals and the PBR is 66 animals. No fishery-related takes or strandings were reported between 2007 and 2011 (Carretta et al. 2014).

The estimated abundance of the Northern California-Southern Oregon stock, based on aerial surveys in 2007-2011, is 35,769 harbor porpoises (Carretta et al. 2014). The minimum population estimate is 23,749 animals and the PBR is 475 animals. Stranding data from 2007 indicate interactions with entangling net fisheries for an estimated level of known human-caused mortality and serious injury of ≥ 0.6 harbor porpoises per year (Carretta et al. 2014).

The most recent surveys from which estimates were derived for the Northern Oregon/Washington coastal stock of harbor porpoises were in 2010-2011. Adjusted for groups missed by aerial observers, the corrected estimate of abundance for harbor porpoise in the coastal waters of northern Oregon (north of Lincoln City) and Washington is 21,487 (Carretta et al. 2014). The minimum population estimate is 15,123 animals and the PBR is 151 animals. Stranding data from 2007-2011 indicate interactions with entangling net fisheries for an estimated minimum level of known fishery-related mortality of ≥ 3.0 harbor porpoises per year (Carretta et al. 2014).

Aerial surveys of the Washington inland waters stock conducted during August of 2002 and 2003 included the Strait of Juan de Fuca, San Juan Islands, Gulf Islands, and Strait of Georgia. This area also includes waters inhabited by harbor porpoise from British Columbia. (Carretta et al. 2013). Tagging studies indicate multi-season residency of harbor porpoise in the Strait of Juan de Fuca, Haro Strait, and Georgia Strait (Hanson 2007). The corrected abundance estimate for the Washington inland waters stock of harbor porpoise in 2002/2003 is 10,682 (CV=0.38) animals (Carretta et al. 2013). Since these data are >8 years old, there are no estimates of minimum population size, trends, or PBR available for this stock. The minimum total fishery mortality and serious injury for this stock is ≥ 2.2 harbor porpoise per year (Carretta et al. 2014).

Harbor porpoises in the eastern North Pacific occur throughout coastal waters from Point Conception, California to Alaska and across to Russia (Carretta et al. 2013). They frequent inshore areas, shallow bays, estuaries, and harbors and are found almost exclusively shoreward of the 200 m contour line, with the vast majority found inside the 50 m curve (Gearin and Scordino 1995; Osmek et al. 1996).

Dall's porpoise

The most recent estimated population size for the California/Oregon/Washington stock of Dall's porpoise is 42,000. The minimum population estimate is 32,106 and the PBR is 257 animals (Carretta et al. 2014). Dall's porpoise also occur in the inland waters of Washington state, but the most recent abundance estimate from 1996 (900 animals) is outdated and not included in the overall abundance estimate for this stock. The average annual human-caused mortality in 2004-2008 was ≥ 0.4 animals and attributed to takes in the groundfish trawl fishery and the Puget Sound salmon drift gillnet fishery (Carretta et al. 2014).

Dall's porpoise occur only in temperate waters of the North Pacific and adjacent seas (Jefferson 2009). It is probably the most widely distributed cetacean in temperate and subarctic regions of the North Pacific and Bering Sea. This oceanic species is found along the continental shelf and in inland and coastal waters, with poorly understood seasonal inshore-offshore and north-south movements (Jefferson 2009). Movements of radio-tagged Dall's porpoise between the San Juan Islands, WA and the outer coast coincide with the timing of development of the Juan de Fuca eddy (Hanson 2007).

Pacific white-sided dolphin

Pacific white-sided dolphin stock structure is poorly understood. There may be two forms along the U.S. West Coast, but they are managed as a single unit since they are difficult to readily distinguish (Carretta

et al. 2013). Pacific white-sided dolphins may spend time outside the U.S. Exclusive Economic Zone (EEZ), so a multi-year average abundance estimate for California, Oregon, and Washington is used for management within U.S. waters. The 2005-2008 geometric mean abundance estimate for California, Oregon and Washington waters is 26,930, with a minimum estimate of 21,406 dolphins (Carretta et al. 2014). Barlow and Forney (2007) estimated the density of Pacific white-sided dolphins off California, Oregon, and Washington at 20.93 dolphins/1000 km². The PBR is 171 animals (Carretta et al. 2014). The average annual human-caused mortality of 17.8 dolphins in 2007-2011 includes commercial fishery (11.8/yr) and research-related mortality (6.0/yr). This is well below PBR and total fishery mortality and serious injury for this stock is less than 10% of the calculated PBR, so can be considered to be approaching zero mortality and serious injury rate (Carretta et al. 2014).

Pacific white-sided dolphins are endemic to temperate waters of the North Pacific Ocean. Off the U.S. West Coast, they occur primarily in shelf and slope waters and, occasionally, in the Strait of Juan de Fuca and Puget Sound. Sighting patterns from surveys conducted off California, Oregon, and Washington suggest seasonal north-south movements, with animals generally found off California during the colder water months and shifting northward towards Oregon and Washington as water temperatures increase in late spring and summer (Carretta et al. 2014 and citations therein). There is evidence that a northward shift in occurrence at the northern and southern range limits coincides with increasing water temperature since the 1980s (Salvadeo et al. 2010).

Risso's dolphin

Risso's dolphins may range beyond the U.S. EEZ as oceanographic conditions vary, so a multi-year average abundance estimate for the California/Oregon/Washington stock is used for management within U.S. waters. The resulting abundance estimate, derived from ship surveys in 2005 and 2008, is 6,272 animals. The minimum population estimate is 4,913 and the PBR is 39 animals (Carretta et al. 2014). Barlow and Forney (2007) estimated the density of Risso's dolphins at 10.46 dolphins/1000 km². There is no apparent trend in abundance between the most recent survey years 1991 and 2008 (Carretta et al. 2014). The average annual human-caused (fishery-related) mortality was 1.6 dolphins for the period of 2004 to 2008. This is well below PBR and total fishery mortality and serious injury for this stock is less than 10% of the calculated PBR, so can be considered to be approaching zero mortality and serious injury rate (Carretta et al. 2014).

Risso's dolphins are distributed world-wide in tropical and warm-temperate waters, preferentially along steep slopes in waters between 400 m and 1000 m deep. In the North Pacific, they have occurred as far north as the Gulf of Alaska and the Kamchatka Peninsula (Baird 2009). Off the U.S. West Coast, they commonly occur in slope and offshore waters of California, Oregon and Washington (Carretta et al. 2013). Animals may shift northward along the coast with increasing water temperatures during late spring and summer. Risso's dolphins were acoustically detected off the outer coast of Washington an average of five to six days per year, but were only visually observed on two occasions (Oleson et al. 2009).

Bottlenose dolphin

The two forms of common bottlenose dolphins recognized in the western North Pacific Ocean are the California coastal stock (coastal) and California/Oregon/Washington offshore (offshore) stock. The estimated population of 323 for the coastal stock was based on photographic mark-recapture surveys conducted along the San Diego coast in 2004 and 2005. Accounting for dolphins without distinguishing markings, the population size may be closer to 450-500 animals, with a minimum population estimate of 290 animals and a PBR of 2.4 dolphins per year. The population has remained stable for about 20 years (summarized in Carretta et al. 2014, and citations therein). Total annual fishery mortality and serious injury for this stock (≥ 0.2 per year) is less than 10 percent of PBR (Carretta et al. 2013).

The offshore stock may spend time outside of the U.S. EEZ and distribution may vary inter-annually, so a multi-year average abundance estimate is used for management within U.S. waters. The most comprehensive estimate is 1,006 dolphins, derived from California, Oregon, and Washington ship surveys in 2005 and 2008. The minimum population estimate is 684 and the PBR is 5.5 animals per year (Carretta et al. 2014). No information on trends in abundance of offshore bottlenose dolphins is available. Total annual fishery mortality and serious injury for this stock (≥ 0.2 per year) is less than 10 percent of PBR (Carretta et al. 2014).

Bottlenose dolphins occur worldwide in tropical and warm-temperate waters and range as far north as the southern Okhotsk Sea, Kuril Islands, and central California in the North Pacific (Wells and Scott 2009). Although primarily coastal, they also occur in pelagic waters, near oceanic islands, and over the continental shelf. California coastal bottlenose dolphins occur within about one kilometer of shore from Point Conception (but as far north as San Francisco) south into Mexican waters. As summarized in Carretta et al. (2014, and citations therein), offshore bottlenose dolphins occur farther than a few kilometers from mainland California and throughout the Southern California Bight, as well as in offshore waters as far north as 41°N and possibly into Oregon and Washington waters during warm water periods. There is no apparent seasonality in distribution. Bottlenose dolphins sightings and strandings are very rare in Puget Sound. Multiple sightings and the eventual stranding of an individual in 2011 was only the fourth documented occurrence of this species in the area since 1988 (Cascadia Research Collective 2011a).

Striped dolphin

Striped dolphin abundance in this region is variable and likely influenced by oceanographic conditions. Because animals may spend time outside the U.S. EEZ as oceanographic conditions change, a multi-year average abundance estimate is used for management within U.S. waters. The 2005-2008 geometric mean abundance estimate for California, Oregon, and Washington waters is 10,908 striped dolphins. The minimum population estimate is 8,231 and the PBR is 82 striped dolphins per year (Carretta et al. 2014). The average annual human-caused mortality for 2004-2008 of 0.2 dolphins is based on a single stranding of a striped dolphin with evidence of possible impact or fisheries interaction. There were no directly observed incidental takes during this time period (Carretta et al. 2014).

Striped dolphins occur worldwide in cool-temperate to tropical zones. They are usually found beyond the continental shelf, over the continental slope out to oceanic waters where they associate with convergence zones and waters influenced by upwelling. Striped dolphins have been sighted during surveys within about 100-300 nmi of the California coast. No sightings have been reported for Oregon and Washington waters, but striped dolphins have stranded in both states (Carretta et al. 2013).

Short-beaked common dolphin

Short-beaked common dolphin distribution off the U.S. West Coast appears to vary seasonally and inter-annually in response to changing oceanographic conditions. Their range extends beyond the U.S. EEZ, so a multi-year average abundance estimate is used for management within U.S. waters. The geometric mean abundance estimate, based on summer/fall shipboard surveys off the coasts of California, Oregon, and Washington in 2005 and 2008, is 411,211 short-beaked common dolphins. The minimum population estimate is 343,990 and the PBR is 3,440 dolphins per year (Carretta et al. 2014). Mean annual incidental mortality and serious injury of short-beaked common dolphins in commercial fisheries for 2004-2008 is 64 animals (Carretta et al. 2014).

Short-beaked common dolphins are the most abundant dolphin in offshore warm-temperate waters in the Atlantic and Pacific, where they occur from about 40°N to about 50°S (Perrin 2009). They are the most abundant cetacean off California, and are widely distributed between the coast and at least 300 nmi distance from shore (Carretta et al. 2013). The short-beaked common dolphin is found in coastal and

offshore waters along the eastern Pacific coast from Peru to Vancouver Island (Carretta et al. 2013). They occasionally occur in waters cooler than 12° C and within the Puget Sound (DON 2008).

Long-beaked common dolphin

Long-beaked common dolphins were not recognized as a distinct species until the 1990s. Their distribution along the U.S. West Coast overlaps that of short-beaked common dolphins and historical data generally did not distinguish between the two species. The most recent abundance estimate of 107,016 is based on 2008 and 2009 ship surveys off California, Oregon, and Washington. The minimum population estimate for the California stock is 76,224 and the PBR is 610 dolphins (Carretta et al. 2014). Average annual human-caused mortality and serious injury is 13.8. This includes 13.0 dolphins per year in commercial fisheries (2006-2010) and a 2007-2011 average annual mortality (0.8 dolphins) resulting from a single blast trauma event associated with underwater detonations by the U.S. Navy near San Diego in 2011 (Carretta et al. 2014).

Long-beaked common dolphins are common within about 50 nmi of shore, from Baja California northward to about central California. California waters represent the northern limit for this stock. Abundance of common dolphins off California may change with varying oceanographic conditions (Carretta et al. 2013). The long-beaked species seems to prefer shallower and warmer water and generally occurs closer to shore than the short-beaked form (Perrin 2009). They are extremely rare in Puget Sound, with the only recorded sightings being of a pair near Olympia, WA in 2003 and repeated sightings of one to two individuals, also near Olympia, during summer and early fall of 2011 (Cascadia Research Collective 2011b, Huggins et al. 2011). These rare northerly sightings of long-beaked common dolphins in Puget Sound and, similarly, in waters off British Columbia in 1993, 2002, and 2003 are likely associated with warm-water oceanographic events (Ford 2005).

Northern right whale dolphin

Northern right whale dolphins range beyond the U.S. EEZ as oceanographic conditions vary, so a multi-year average abundance estimate for the California/Oregon/Washington stock is used for management within U.S. waters. The resulting abundance estimate, derived from ship surveys in 2005 and 2008, is 8,334 animals. The minimum population estimate is 6,019 and the PBR is 48 animals (Carretta et al. 2014). Barlow and Forney (2007) estimated the density of northern right-whale dolphins at 9.75 dolphins/1000 km². The average annual human-caused mortality of northern right whale dolphins is 4.8 (3.6 commercial fishery-related, 1.2 research-related) for 2004 to 2008. This is well below PBR and total fishery mortality and serious injury for this stock does not exceed 10% of the calculated PBR, so can be considered to be approaching zero mortality and serious injury rate (Carretta et al. 2014).

Northern right whale dolphins are endemic to the North Pacific Ocean, occurring primarily in cool-temperate continental shelf and slope waters; they are rare inshore. In the eastern North Pacific, they range from the Gulf of Alaska to southern California (Lipsky 2009). They show apparent seasonal north-south movements, occurring off California during the colder months and shifting northward with increasing water temperatures in the spring and summer (Carretta et al. 2014).

California sea lion

California sea lions breed in three geographic regions which are used to separate the subspecies into three stocks: (1) the U.S. stock begins at the U.S./Mexico border and extends northward into Canada; (2) the Western Baja California stock extends from the U.S./Mexico border to the southern tip of the Baja California Peninsula; and (3) the Gulf of California stock includes the Gulf of California from the southern tip of the Baja California peninsula (Carretta et al. 2013). Based on extrapolations from pup counts, the population is estimated at 296,750 sea lions and increasing at 5.4 percent per year (Carretta et al. 2014). Revised estimates of total population size are currently being developed based on 2011 pup

counts of 61,943 animals (Carretta et al. 2015). The minimum population estimate for the U.S. stock (based on 2007 counts) is 153,337 sea lions, with a calculated PBR of 9,200 animals (Carretta et al. 2014). The total annual human-caused mortality of California sea lions, 2008-2012, is at least 389 animals. The average annual commercial fishery-related mortality is 331 sea lions. Other sources of human-caused mortality (e.g., shootings, direct removals, recreational hook-and-line fisheries, tribal takes, entrainment in power plant intakes, and incidental research takes) account for an average of 58 sea lions per year. This is less than the total calculated PBR and the total fishery mortality is less than 10% of the PBR, so is considered to be insignificant and approaching a zero mortality and serious injury rate (Carretta et al. 2015).

The primary rookeries for the U.S. stock are located on the California Channel Islands of San Miguel, San Nicolas, Santa Barbara, and San Clemente. As summarized in Carretta et al. (2013) and DON (2008), and references therein) their distribution shifts to the northwest in fall and to the southeast during winter and spring, probably in response to changes in prey availability. They are occasionally sighted up to several hundred kilometers offshore. California sea lions frequently travel up river systems in search of prey. They are common at the Bonneville Dam, 235 kilometers (141 miles) upriver from the mouth of the Columbia River, where they prey on adult salmonids, including threatened Chinook salmon and steelhead, passing the dam in the spring (NMFS 2008c). This predation concern continues up the coast of Washington State, and affects fisheries as far north as the Quillayute River. California sea lions consumed an estimated 2.2% of the salmonid run in 2010 (Stansell et al. 2010). In 2014, 71 California sea lions were observed at Bonneville Dam, with maximum in a single day of 27 and a mean daily occurrence of 4.6 sea lions. Sightings peak in April. Since regular observations began in 2005, numbers of California sea lions recorded at Bonneville Dam ranged from 39 to 89 individuals (Stansell et al. 2014). California sea lions are present in Washington waters primarily during the non-breeding season of September to May, including concentrations in Puget Sound near Everett. They also occur along several coastal areas of Oregon and in several coastal bays and rivers (NMFS 1997).

Steller sea lion: Eastern Stock

The two separate stocks of Steller sea lions recognized in U.S. waters are the eastern stock, which includes animals east of Cape Suckling, AK (144o W) to California, and a western stock that extends from west of Cape Suckling to Russia (Loughlin 1997). In November 1990, NMFS listed Steller sea lions as threatened under the ESA (55 FR 49204). In 1997, the western population was listed as endangered (62 FR 24345, June 1997), while the eastern stock retained a threatened classification (Allen and Angliss 2013). In November 2013, NOAA delisted the eastern stock, by removing it from the ESA list of threatened and endangered species; the endangered status for the western stock remains unchanged. NMFS intends to implement a Post-Listing Monitoring Plan for the next ten years to ensure continued recovery of the eastern stock of Steller sea lions (78 FR 66140, November 4, 2013). Delisting the eastern stock of Steller sea lions did not remove or modify Steller sea lion critical habitat, designated in 1993 (58 FR 45269, August 27, 1993). Existing critical habitat designation will remain in place until NMFS undertakes a separate rulemaking to consider amending designation (78 FR 66140, November 4, 2013).

Based on extrapolations from non-pup and pup surveys, the total population of the eastern stock of Steller sea lions is estimated to range from 63,160 to 78,198 with a minimum population estimate of 57,996 for the entire stock and 34,485 for the U.S. portion of the stock. The calculated PBR for the U.S. portion of the stock is 1,552 sea lions per year (Allen and Angliss 2014). Overall the stock has been increasing at about 3.1 percent per year since the 1970s with the population more than doubling in size by 2004, principally in Southeast Alaska (Pitcher et al. 2007). The recent status review (NMFS 2013b) shows the population met recovery criteria outlined in the recovery plan developed by NOAA fisheries in 1992 and revised in 2008. Total estimated annual human-caused mortality and serious injury is 65.1 sea lions. The minimum estimated U.S. commercial fishery-related mortality and serious injury for this stock is 17

animals. In 2008, two Steller sea lions died in traps at Bonneville Dam as part of the lethal take program targeting California sea lions (Allen and Angliss 2014).

The eastern stock of Steller sea lion is present year round within the California Current Ecosystem, with peak numbers in late summer, fall, and winter (Carretta et al. 2011). There are currently six major haulouts (used by >50 animals) and three active rookeries in California, seven major haulouts and two rookeries in Oregon, and two major haulout sites along the outer coast of Washington (Pitcher et al. 2007). Sea lions commonly occur near and beyond the 200 m depth contour, while some individuals enter rivers in pursuit of prey. Steller sea lions commonly haulout on the tip of the South Jetty in the Columbia River and are occasionally seen at the East Mooring Basin, Phoca Rock, and Bonneville Dam areas of the river (<http://www.nwr.noaa.gov/Marine-Mammals/upload/MM-Steller-locations-OR.pdf>). Steller sea lions have been observed preying on salmonids and white sturgeon at the Bonneville Dam, over 200 kilometers up the Columbia River (Stansell et al. 2010). In 2014, 65 Steller sea lions were observed at Bonneville Dam, with a maximum of 41 observed on two different days and a mean daily occurrence of 9.9 Steller sea lions. Peak sightings are in April. Since regular observations began in 2005, numbers of Steller sea lions recorded at Bonneville Dam ranged from four in 2005 to 89 in 2011 (Stansell et al. 2014).

Northern fur seal

Northern fur seals are divided into two stocks in U.S. waters: Eastern Pacific stock (Pribilof Islands and Bogoslof Island) and California stock (includes San Miguel Island and Farallon Islands). The California stock is included here. The population estimate for the California stock (12,844) incorporates estimates from San Miguel Island (12,368) and the Farallon Islands (476). The minimum population estimates are 6,722 for the California stock and 6,431 and 291 for San Miguel Island and the Farallons, respectively (Carretta et al. 2014). The calculated PBR for the California stock is 403 northern fur seals per year. The minimum annual human-caused mortality and serious injury is 2.6, which is well below PBR. The minimum annual fishery-related mortality and serious injury level is 0.4, and, thus, appears to be approaching a zero mortality and serious injury rate (Carretta et al. 2014).

Northern fur seals are endemic to the North Pacific Ocean. During the winter, the southern limit of their range extends across the Pacific Ocean from southern California to the Okhotsk Sea and Honshu Island, Japan. In the spring most northern fur seals migrate north to breeding colonies in the Bering Sea, primarily on the Pribilof Islands. Smaller populations (e.g., the California stock) occur on San Miguel Island off the southern California coast and the Farallon Islands off central California (NMFS 2007b). While at sea, fur seals feed primarily along the subpolar continental shelf and shelf break from the Bering Sea to California, with highest densities associated with major oceanographic frontal features, including sea mounts, valleys, and canyons (NMFS 2007b).

Harbor Seal

There are five presently recognized subspecies of harbor seal. *P.v. richardsi* is the subspecies that occurs along the West Coast of North America (Burns 2009). Three harbor seal stocks are recognized within this subspecies: the California stock, the Oregon/Washington coastal stock, and Washington inland waters stock (Carretta et al. 2013, Lamont et al. 1996). Genetic analyses indicate that the Washington inland waters stock may actually consist of three genetically distinct populations (north Inland Waters, Hood Canal, and south Puget Sound (Huber et al. 2010, Huber et al. 2012). The California stock is estimated as 30,968 seals with a minimum population estimate of 27,348 seals and a calculated PBR of 1,641 seals per year (Carretta et al. 2015). The Oregon/Washington coastal stock was estimated at 24,732 harbor seals in 1999. Because this estimate is >8 years old, current information on abundance is unavailable and neither a minimum population estimate nor PBR could be calculated for this stock (Carretta et al. 2014). The number of seals in the Washington inland waters stock was estimated as 14,612. This estimate is also >8

years old, so there is no current estimate of abundance and a minimum population estimate and PBR could not be calculated for this stock (Carretta et al. 2014). Based on currently available data, the level of human-caused mortality and serious injury (31, 10.6, and 13.4 per year for the California stock (2005-2009), Oregon/Washington coastal stock (2007-2011), and Washington inland waters stocks (2007-2011), respectively) does not exceed the calculated PBR for the California stock and is unknown, but unlikely exceeds, PBR for the others. The minimum estimated fishery mortality and serious injury (30, 8.2, 4.0 per year for the California stock, Oregon/Washington coastal stock, and Washington inland waters stocks, respectively) is less than 10 percent of the calculated PBR for the California stock and is unknown, but likely less than 10 percent of PBR for the other stocks (Carretta et al. 2014).

Harbor seals are the most widespread of any pinniped, distributed in nearshore temperate and arctic waters of the northern hemisphere of both the Atlantic and Pacific Oceans. They occur year-round in Washington. Harbor seals use hundreds of sites to rest or haulout along the coast and inland waters (such as Puget Sound), including intertidal sand bars and mudflats in estuaries, intertidal rocks and reefs, sandy, cobble, and rocky beaches, islands, log-booms, docks, and floats in all marine areas of the state. Group sizes typically range from small numbers of animals on some intertidal rocks to several thousand animals found seasonally in coastal estuaries (Burns 2009). Harbor seals occasionally occur at the Bonneville Dam up the Columbia River, but no more than three are usually seen in a year (Stansell et al. 2010). From 2002 to 2014, harbor seal counts at the Bonneville Dam ranged from zero to three, with one to two sightings typical of most years (Stansell et al. 2014).

3.2.3 Birds

3.2.3.1 Threatened and Endangered Species

The ESA allows the USFWS to list bird species as endangered or threatened regardless of which country the species lives in. Although greater legal protections are given to ESA-listed species within the U.S. EEZ, the law also provides protection to listed species wherever they occur from potentially adverse interactions with people and entities subject to U.S. jurisdiction, such as the NWFSC and its researchers.

There are four ESA-listed bird species occurring within the NWFSC research areas. Table 3.2-5 lists their status and occurrence in each of the three NWFSC research areas. The following accounts describe each species' distribution within the three research areas, a summary of the basic life history, population trends, and any documented interaction with the U.S. West Coast groundfish fisheries.

Table 3.2-5 ESA-listed Birds Occurring in the NWFSC Research Areas

Species		California Current	Puget Sound	Lower Columbia River
Common Name and Status	Scientific Name			
Short-tailed albatross (Endangered)	<i>Phoebastria albatrus</i>	Yes	No	No
California least tern (Endangered)	<i>Sterna antillarum browni</i>	Yes	No	No
Marbled murrelet (Thretened)	<i>Brachyramphus marmoratus</i>	Yes	Yes	Yes
Western snowy plover (Thretened)	<i>Charadrius alexandrinus nivosus</i>	Yes	No	Yes

Short-tailed Albatross

The short-tailed albatross may occur in the CCRA only. It breeds on Midway Island in the northwestern Hawaiian Islands and Torishima and Bonin Islands near Japan. An estimated 450 pairs are thought to exist, the majority of which breed at Torishima. They are occasionally sighted off the Pacific Coast of the United States, south to California. This species spends most of its life in flight over the Pacific Ocean

when not nesting, ranging from the coasts of Russia and Asia, Hawaii, and the Pacific Coast of North America.

The short-tailed albatross is a very large seabird with narrow, seven-foot-long wings adapted for soaring low over the ocean. The species used to be the most abundant albatross in the North Pacific but was almost exterminated by feather and meat hunters on its Japanese breeding grounds in the early 1900s. The short-tailed albatross was listed as endangered by the USFWS in 2000 and a Final Recovery Plan was published in 2008 (USFWS 2008a). Conservation efforts have helped the population grow at near-maximum rates but the total population is still less than 3,000 birds (USFWS 2009a).

Short-tailed albatross mate for life, returning to the same nest sites in the breeding colony for many years. Single eggs are laid in October or November, chicks hatch in December through February, and the young fledge from May to July. Immature birds wander across the North Pacific until they begin breeding at 6 to 9 years old (USFWS 2008a).

Short-tailed albatross forage for small fish (e.g., larval and juvenile Pollock and sablefish), squid, and zooplankton from the surface of the water or just below it along the edge of the continental shelf, and on the outer shelf where upwellings bring their prey to the surface. Albatross are attracted to fishery wastes released from fishing vessels and processors and are thus vulnerable to being caught in fishing gear, especially on baited hooks in the longline fisheries.

Major threats to this species include natural threats to their nesting habitat on volcanic islands, mortality in longline fisheries, and ingestion of plastic debris (USFWS 2008a). In 2002 a short-tailed albatross was recorded feeding on catch during the U.S. West Coast ground fishery, but no takes were documented between 2002 and 2009 (Jannot 2011). In April 2011 a short-tailed albatross was killed by a longline fishing boat off the coast of Oregon, the first bycatch of a short-tailed albatross to be observed in the Pacific Northwest (American Bird Conservancy 2011).

California Least Tern

The California least tern may occurs with regularity in the CCRA. It has been recorded rarely as a vagrant off the coast of Washington and Oregon (Birdweb 2013).

The following information is summarized from the USFWS's 5-year review (USFWS 2006). The California least tern is the smallest of the North America terns and is found along the Pacific Coast of California, from San Francisco southward to Baja California. The California least tern nests in colonies on relatively open beaches and forage primarily in near shore ocean waters and in shallow estuaries and lagoons. They are very gregarious and forage, roost, nest, and migrate in colonies. This species was listed as endangered by the USFWS in 1970, and a recovery plan was published in 1980 (USFWS 1985).

Historically abundant, California least tern numbers had declined to about 600 pairs in the U.S. at the time of listing; since then active management has increased the numbers to approximately 7,100 in 2005. More effective management at existing nest sites and greater number of nest sites are needed to downlist the species from endangered to threatened (USFWS 2009b).

Major threats to this species include human use and development of nesting habitat and predation on adults, eggs, and young by birds and mammals, and habitat loss due to encroachment of vegetation (USFWS 1985, USFWS 2006). There are no records of California least terns interacting with the U.S. West Coast ground fishery between 2002 and 2009 (Jannot 2011).

Marbled Murrelet

The marbled murrelet may occur in any of the three research areas.

The marbled murrelet is a small seabird that breeds in coniferous trees with old growth characteristics along the Pacific coast from Alaska to northern Mexico, as far inland as 55 miles from marine waters. The southern population was listed as threatened in Washington, Oregon, and California in 1992 due to habitat loss from logging and coastal development, susceptibility to oil spills, and mortality in gill-net fisheries (USFWS 1997a). Critical habitat was designated in 1996 and revised in 2011 in forested breeding habitat in Washington, Oregon, and California.

In Washington State, areas of winter concentration are the southern and eastern end of the Strait of Juan de Fuca, Sequim (Clallam County), Discovery and Chuckanut Bays (Whatcom County), the San Juan Islands (San Juan County) and Puget Sound. The southern Washington coast is also considered an important wintering area. When seen offshore, marbled murrelets are typically found in pairs and within a mile of shore. During the breeding season, they are present along almost all of Washington's marine shoreline, concentrated in areas with abundant food and nearby nesting habitat. These areas of concentration are Tongue Point and Voice of America on the Olympic Peninsula, the south shore of Lopez Island, the southwest shore of Lummi Island, and Obstruction and Peavine Passes between Orcas and Blakely Islands in the San Juan Islands (Birdweb 2013). In Oregon, Marbled Murrelets were found to be most abundant off the central part of the state from Coos Bay north to Cascade Head (Varoujean and Williams 1995). California distribution/abundance. The following information is summarized from the USFWS's species profile (USFWS 2011). Marbled murrelets are long-lived seabirds that spend most of their life in the marine environment, but use old-growth forests for nesting. Courtship, foraging, loafing, molting, and preening occur in near-shore marine waters. They are a diving duck and feed primarily on fish and invertebrates captured underwater in near-shore marine waters although they have also been seen on rivers and inland lakes.

Marbled murrelets produce one egg per nest and usually only nest once a year, however re-nesting is documented. Nests are not built, but rather the egg is placed in a small depression or cup made in moss or other debris on the limb. For known nests in Washington, Oregon and British Columbia, egg laying may begin as early as late April, and the last known fledging of a chick is September 23 (Emily Teachout, USFWS personal communication 2013). Incubation lasts about 30 days, and chicks fledge after about 28 days after hatching. Both sexes incubate the egg in alternating 24-hour shifts. The chick is fed up to eight times daily, and is usually fed only one fish at a time. Fledglings fly directly from the nest to the ocean.

All population trend modeling has concluded that the species exhibits a long-term downward trend, averaging a 3.7% annual decline rangewide between 2001 and 2010 (Emily Teachout, USFWS personal communication 2013). Juvenile recruitment is very low in the Washington State region (Puget Sound and Washington Coast).

The amount of suitable habitat has continued to decline throughout the range of the marbled murrelet, primarily due to commercial timber harvest. The precise amount of suitable murrelet habitat within the listed range is unknown.

Threats include loss of habitat, predation by corvids, raptors and small mammals, gill-net fishing operations, oil spills, marine pollution, terrestrial noise and disturbance near nests, underwater pile driving noise and disease. In 2002 a marbled murrelet was observed boarding a vessel during the U.S. West Coast ground fishery, but no takes were documented between 2002 and 2009 (Jannot 2011).

Western Snowy Plover

The western snowy plover may occur in the CCRA and LCRA.

The western snowy plover is a small shorebird that nests on the mainland coast, peninsulas, offshore islands, bays, estuaries, salt ponds, and rivers of the Pacific Coast from southern Washington to southern Baja California, Mexico. Snowy plover have very limited use of the marine environment; they forage on tidal mudflats and may migrate a short distance from the shoreline.

The Pacific coast population of the western snowy plover was listed as threatened on March 5, 1993. Critical habitat was designated at 32 beach areas along the coasts of California, Oregon, and Washington in 2005, and expanded in June 2012. A recovery plan was published in 2007.

The following information is summarized from the USFWS's species profile. Pacific coast plovers typically forage for small invertebrates in wet or dry beach-sand, among tide-cast kelp, and within low foredune vegetation. Some plovers use dry salt ponds and river gravel bars. Clutches, which most commonly consist of three eggs, are laid in shallow scrapes or depressions in the sand. Pacific coast snowy plovers are polyandrous (i.e., a female may breed with more than one male), and share incubation duties. Females typically desert the brood shortly after hatching, leaving the chick rearing duties to the male. Snowy plover chicks are precocial, leaving the nest within hours after hatching to search for food. Males attend the young until they fledge, which takes about a month.

The USFWS (2012b) estimates that about 2,500 western snowy plovers breed along the Pacific Coast from early March to late September. Prior to 1970 the coastal population was thought to have nested at more than 50 locations along the coast. Today, only 28 major nesting areas remain (USFWS 2012b)

The population decline is attributed to poor reproductive success caused by human disturbance, predation, and inclement weather, combined with permanent or long-term loss of nesting habitat due to encroachment of non-native European beachgrass and urban development (USFWS 1993).

There are no records of western snowy plovers interacting with the U.S. West Coast ground fishery between 2002 and 2009 (Jannot 2011).

3.2.3.2 Other Bird Species

There are many seabird species that occur in the three NWFSC fisheries research areas which may potentially interact with research vessels and gear. Many bird species have been taken during the U.S. West Coast groundfish fishery. The following accounts give brief overviews of the marine bird communities in the research areas.

California Current

The California Current Ecosystem supports over 150 species of breeding and migrating seabirds, including sea ducks, loons, grebes, albatross, petrels, shearwaters, storm-petrels, tropicbirds, boobys, cormorants, pelicans, phalaropes, gulls, terns, murre, murrelets, auklets, and puffins (Mills et al. 2005). All species likely to occur in the California Current research area are protected by the Migratory Bird Treaty Act (MBTA) (16 U.S.C. 703 *et. seq.*) as well as conservation laws in Canada and Mexico. Some species travel long distances over the ocean and have many potentially adverse interactions with humans and their activities, such as commercial and recreational fisheries and oil spills from transport vessels and offshore oil wells. Human activities on land can also affect them at sea or at inland nest sites, including agricultural and urban runoff contamination and land clearing for resource development (Mills et al. 2005). However, natural factors such as changes in ocean currents, prey availability, and severe weather can drive population fluctuations for many species (Ainley and Hyrenbach 2007). The impacts of climate change on weather, ocean chemistry, and oceanographic patterns and the ecological effects on different bird species is a topic of considerable interest and research (Sydeman et al. 2009).

Puget Sound

The Puget Sound ecosystem provides habitat for about 100 species of seabirds. The Puget Sound Seabird Survey reports that 59 species of seabirds regularly use Puget Sound, and another 37 species are found rarely. The most common seabirds found in Puget Sound include loons, grebes, sea ducks, cormorants, murre, murrelets, guillemot, auklets, puffins, jaegers, gulls, and terns. Year-round residents in Puget Sound include tufted puffin (*Fratercula cirrhata*), pelagic cormorant (*Phalacrocorax pelagicus*), double-

crested cormorant (*Phalacrocorax auritus*), pigeon guillemot (*Cepphus columba*), rhinoceros auklet (*Cerorhinca monocerata*), and glaucous-winged gull (*Larus glaucescens*) (Sedgley 2011).

A 2003-2005 study by scientists from Western Washington University showed significant declines in some seabirds since the Marine Ecosystems Analysis was conducted in Puget Sound in the 1970s. The largest declines were found in common murre (*Uria aalge*), western grebe (*Aechmophorus occidentalis*), red-throated loon (*Gavia stellate*) and Bonaparte's gull (*Larus Philadelpha*) (Bower 2009). Murrelet and scoter populations have also significantly declined since the 1970s (Bower 2009).

Potential risk factors that may be contributing to the decline in marine birds in Puget Sound include pollution, climate change, non-native species, collisions with man-made structures, derelict fishing gear, some fishing practices, prey unavailability, and loss of habitat (Puget Sound Action Team 2007).

Lower Columbia River

The Lower Columbia River area supports more than 250 species of birds, including marbled murrelet, brown pelican (*Pelecanus occidentalis*), Caspian tern (*Hydroprogne caspia*), tufted puffin (*Fratercula cirrhata*), common murre (*Uria aalge*), sooty shearwaters (*Puffinus griseus*), and various species of loons, grebes, cormorants, sea ducks, gulls and terns. Some islands in the river provide important habitat for large nesting colonies of gulls and terns (Pacific Coast Joint Venture 1994). The Lower Columbia area provides habitat for a number of threatened and endangered species, including the northern spotted owl, marbled murrelet. The western snowy plover historically used coastal portions of the area (Pacific Coast Joint Venture 1994).

From the Bonneville Dam to its mouth, the lower Columbia River supports over 70 nesting pairs of bald eagles and provides wintering habitat for more than 100 bald eagles during migration (USFWS 1999). Bald eagles are protected under the Bald and Golden Eagle Protection Act. Nearshore seabirds feast on runs of anchovy and herring at Fort Stevens State Park at the mouth of the Columbia River in July and August. Sooty Shearwaters congregate in the hundreds of thousands in the waters just off the South Jetty of the Columbia River. About 5,000 brown pelicans summer here each year (Patterson 2012).

Potential risk factors for seabirds include interactions with commercial and recreational fisheries, oil spills, increasing urban and industrial development, and climate change. Increasing water temperature of the Columbia River can potentially affect prey availability (Lower Columbia River Estuary Partnership 2010). Pollution, dams, diking and draining of tidal and freshwater marshes, sedimentation, dredging and river channelization, and clearing of riparian forests have significantly reduced the quantity and quality of habitat in the Lower Columbia River area (Pacific Coast Joint Venture 1994).

3.2.3.3 Species Previously Caught during NWFSC Fisheries Research

Small numbers of seabirds have been caught incidentally in NWFSC research cruises between 2002 and 2013. Table 3.2-6 shows the species, number, status, and presence within the three NWFSC research areas. All five of these seabird species can be found in all three of the research areas but all were caught within the CCRA (Figure 3.2-2).. All were caught and killed during the Juvenile Salmon PNW Coastal Survey using the Nordic 264 surface trawl.

Table 3.2-6 Seabird Species Caught during NWFSC Activities from 2002 through 2013

Common Name	Scientific Name	Number of individuals taken	Status*
Common murre	<i>Uria aalge</i>	12	IUCN - Least Concern WA - Candidate
Rhinoceros auklet	<i>Cerorhinca monocerata</i>	1	IUCN - Least Concern OR - Vulnerable
Cassin's auklet	<i>Ptychoramphus aleuticus</i>	1	IUCN - Least Concern WA – Candidate CA – Special Concern OR - Vulnerable
Tufted puffin	<i>Fratercula cirrhata</i>	2	IUCN - Least Concern WA – Candidate CA – Special Concern OR - Vulnerable
Sooty shearwater	<i>Puffinus griseus</i>	1	IUCN - Near threatened

* IUCN (International Union for Conservation of Nature) – IUCN 2014. IUCN Red List of Threatened Species™

WA – WDFW 2014. Washington State Species of Concern Lists

CA – CDFG 2008. California Bird Species of Special Concern

OR – ODFW 2008. Sensitive Species List

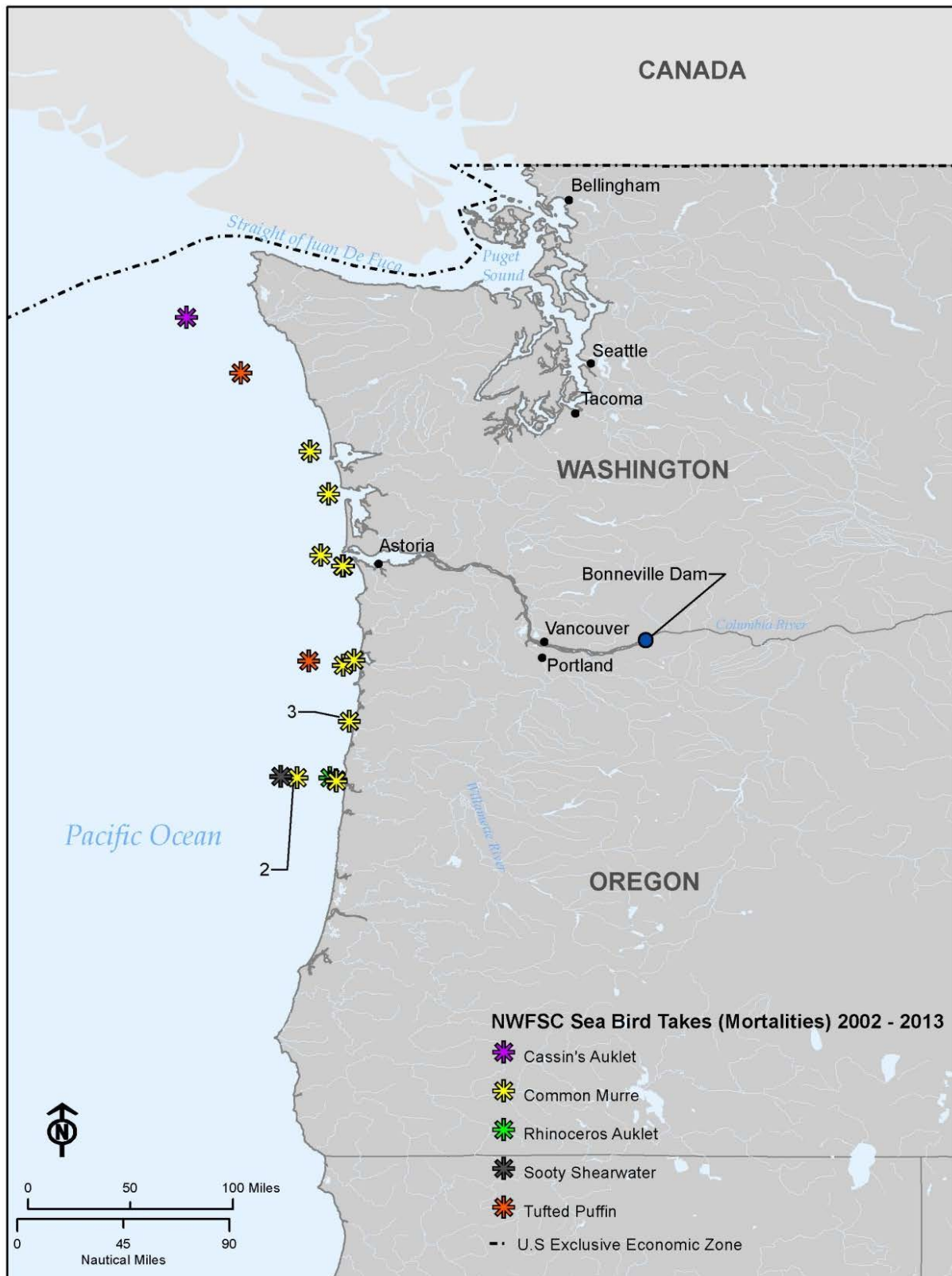


Figure 3.2-2 Locations of Seabird Takes during NWFSC Research from 2002 through 2013

Common Murre

The Pacific breeding population of common murres is estimated at 4.3 million birds (Kushlan et al 2002). This species is abundant, but vulnerable to oil spills and gill-netting. Pacific populations have declined and partially recovered, while Atlantic populations appear to be increasing (Ainley 2002). Tens of thousands of murres in central California were drowned in gill nets between the late 1970s and mid-1980s (USFWS 2012c). In the winter of 1986, the oil barge Apex Houston accidentally discharged some 26,000 gallons of oil while en route from San Francisco to Long Beach Harbor. About 9,900 seabirds were killed as a result of the spill, of which about 6,300 were murres. (USFWS 2012c). Common murres and rhinoceros auklets constituted the greatest portion of the bycatch mortality in coastal drift gillnet salmon fisheries in Puget Sound, WA (USFWS 2005). Thompson et al (1998) estimated over 2,700 murres and 1,000 rhinoceros auklets were killed in 1994 alone in just a portion of the sockeye salmon fishery.

Rhinoceros auklet

World population estimates are extremely rough at 1.5 million breeding birds, with approximately 1 million in the North American segment (Gaston and Dechesne 1996). Rhinoceros auklets are vulnerable to the effects of oil spills; they were the second most common species killed in the Apex Houston oil spill off central CA (Page et al. 1990), and mortalities have been documented in the CA and WA gillnet fisheries (Forney et al. 2001). Raccoons and other introduced mammals have caused catastrophic population losses and possibly total elimination of some colonies (Gaston and Dechense 1996). Mortality of rhinoceros auklets in gillnets is suspected to be an important factor in population declines at Protection Island NWR colonies (USFWS 2005).

Cassin's auklet

The current population size is estimated at 3.6 million breeding birds, with the core of the population located in British Columbia (Manuwal and Thoresen 1993). The Pacific Region encompasses less than 5% of the global population. Populations appear to be declining at several locations throughout their range and several historic colonies have disappeared, mainly due to introduced predators (Manuwall and Thoresen 1993, Denlinger 2006). Research off the southern California coast (Hyrenbach and Veit 2003) has found that, concurrent with rising ocean temperatures, there has been a significant decline in seabird abundance—with particular losses of cold-water taxa, such as Cassin's and rhinoceros auklets (BirdLife International 2008).

Tufted Puffin

The tufted puffin breeding population has been estimated at just under 3 million (Piatt and Kitaysky 2002). Declines of 3 to 21% per annum were estimated for CA, OR, and WA, over the past 15 years (Piatt and Kitaysky 2002). Recent studies suggest that tufted puffins in Washington have undergone a dramatic population decline and nearly a 60% drop in site occupancy over the past 25 or more years; this decline corresponds with similar population trends in California and Oregon (WDFW 2012). Bycatch in fishing nets killed tens of thousands of tufted puffins each year into the 1980s (Piatt and Kitaysky 2002). Elimination of drift-nets on the high seas has reduced mortality, although bycatch in coastal fishing nets still kills large numbers of puffins. In addition, nesting tufted puffins are highly vulnerable to red and arctic foxes, river otters, brown bears, and other mammals. Such predators were once absent from most islands in the northeast Pacific, but were introduced in the 1800s and early 1900s. Where present, mammalian predators have devastated or eliminated tufted puffins from many islands, but programs to eradicate the introduced species have led to dramatic recovery of puffin populations (Piatt and Kitaysky 2002).

Sooty Shearwater

The sooty shearwater is the most abundant seabird off the California coast (USFWS 2005). The global population is roughly estimated to number greater than 20 million (Brooke 2004), but appears to be decreasing (IUCN 2014). Sooty shearwaters wander immense distances from their breeding grounds south of the equator, throughout the Pacific and Atlantic oceans. This makes the species potentially vulnerable to incidental bycatch in fisheries over a huge area. In the California Current, sooty shearwater numbers have fallen by 90% in the last 20 years (Veit et al. 1996). It remains uncertain whether this has resulted from population declines or distributional shifts (Spear and Ainley 1999).

3.2.4 Sea Turtles

Five species of sea turtles can be found within the area of the proposed NWFSC research activities: leatherback, olive ridley, green, loggerhead, and hawksbill sea turtles (Table 3.2-7). None of these turtles nest in the area; their use of the area is limited to migrating and foraging. Additional background information on the range-wide status of these species has been published in a number of documents, including sea turtle status reviews and biological reports (NMFS and USFWS 1995, Hirth 1997, USFWS 1997b) as well as recovery plans for the leatherback sea turtle (NMFS and USFWS 1998a), olive ridley sea turtle (NMFS and USFWS 1998b), green sea turtle (NMFS and USFWS 1998c), loggerhead sea turtle (NMFS and USFWS 1998d), and hawksbill sea turtle (NMFS and USFWS 1998e).

3.2.4.1 Threatened and Endangered Species

All of the sea turtles found in the area of the NWFSC research activities are listed as threatened or endangered under the federal ESA.

Table 3.2-7 ESA-listed Sea Turtles in the NWFSC Research Areas

Species		California Current	Puget Sound	Lower Columbia River
Common Name (Status)	Scientific Name			
Leatherback sea turtle (Endangered)	<i>Dermochelys coriacea</i>	Yes, and Critical Habitat	Unlikely	No, but major feeding area near mouth of Columbia River
Olive Ridley sea turtle (Threatened)	<i>Lepidochelys olivacea</i>	Yes	No	No
Green sea turtle (Threatened)	<i>Chelonia mydas</i>	Yes	Unlikely	No
Loggerhead sea turtle (Threatened)	<i>Carretta carretta</i>	Yes	Unlikely	No
Hawksbill sea turtle (Endangered)	<i>Eretmochelys imbricate</i>	Possible but unlikely	No	No

Leatherback Sea Turtles

The leatherback sea turtle occurs in the CCRA and is unlikely to be found in either the PSRA or LCRRA, although there is a well-known feeding area at the mouth of the Columbia River.

Leatherback sea turtles are widely distributed throughout the oceans of the world and are found in waters of the Atlantic, Pacific, Caribbean, and the Gulf of Mexico (Ernst and Barbour 1972). The leatherback sea turtle is the largest living turtle and ranges farther than any other sea turtle species, exhibiting broad thermal tolerances that allow it to forage into the colder waters (NMFS and USFWS 1995).

The following information is summarized from a recent study of high-use areas in the western Pacific (Benson et al 2011).

Leatherbacks forage in the California Current from early summer to late fall, when water temperatures reach their warmest annual levels and large jellyfish aggregations develop (Graham et al. 2010). Turtles begin to depart the California Current when water temperatures drop in October–November and productivity decreases (Thomas and Strub 2001).

Off Oregon and Washington, potential foraging behavior was observed in continental shelf and slope habitat (200–2000 meters), particularly in waters adjacent to the Columbia River Plume. Both of these CCRA foraging areas support seasonal dense aggregations of gelatinous jellyfish prey, e.g., *Chrysaora fuscescens* and *Aurelia* spp., in retention areas created by points, headlands, and frontal regions (Shenker 1984, Graham et al. 2001). Foraging behavior was also identified in offshore waters of central and northern California, where SST fronts are pronounced during the boreal spring and summer in deeper offshore regions (Costelao et al. 2006).

Critical habitat for the leatherback turtle was designated in areas adjacent to St. Croix, U.S. Virgin Islands in 1979. In January 2012, NMFS designated two additional areas as critical habitat for leatherbacks off the Pacific coast (77 FR 4170). The newly designated critical habitat is made up of two sections of marine habitat where leatherbacks are known to feed on jellyfish. The southern portion stretches along the California coast from Point Arena to Point Arguello east of the 3,000-meter depth contour, while the northern portion stretches from Cape Flattery, Washington to Cape Blanco, Oregon, east of the 2,000-meter depth contour (Figure 3.2-3). This area is known to be the principal Oregon/Washington leatherback foraging area because of high seasonal densities of a primary prey species (brown sea nettle – *C. fuscescens*), and includes important habitat associated with the Columbia River plume (77 FR 4170).

The boundaries of the critical habitat areas were determined by two primary elements that are essential for the conservation of leatherbacks: occurrence of prey species (primarily jellyfish) and migratory pathways to foraging areas. NMFS did not consider commercial fishing, fishing gear, or vessel traffic as potential threats to the leatherback in the critical habitat expansion (75 FR 319). There are no potential fisheries that would target jellyfish, and the bycatch of jellyfish in existing fisheries is limited. For migratory corridors, NMFS determined that only permanent or long-term structures would be considered an impediment to the passage of the turtles.

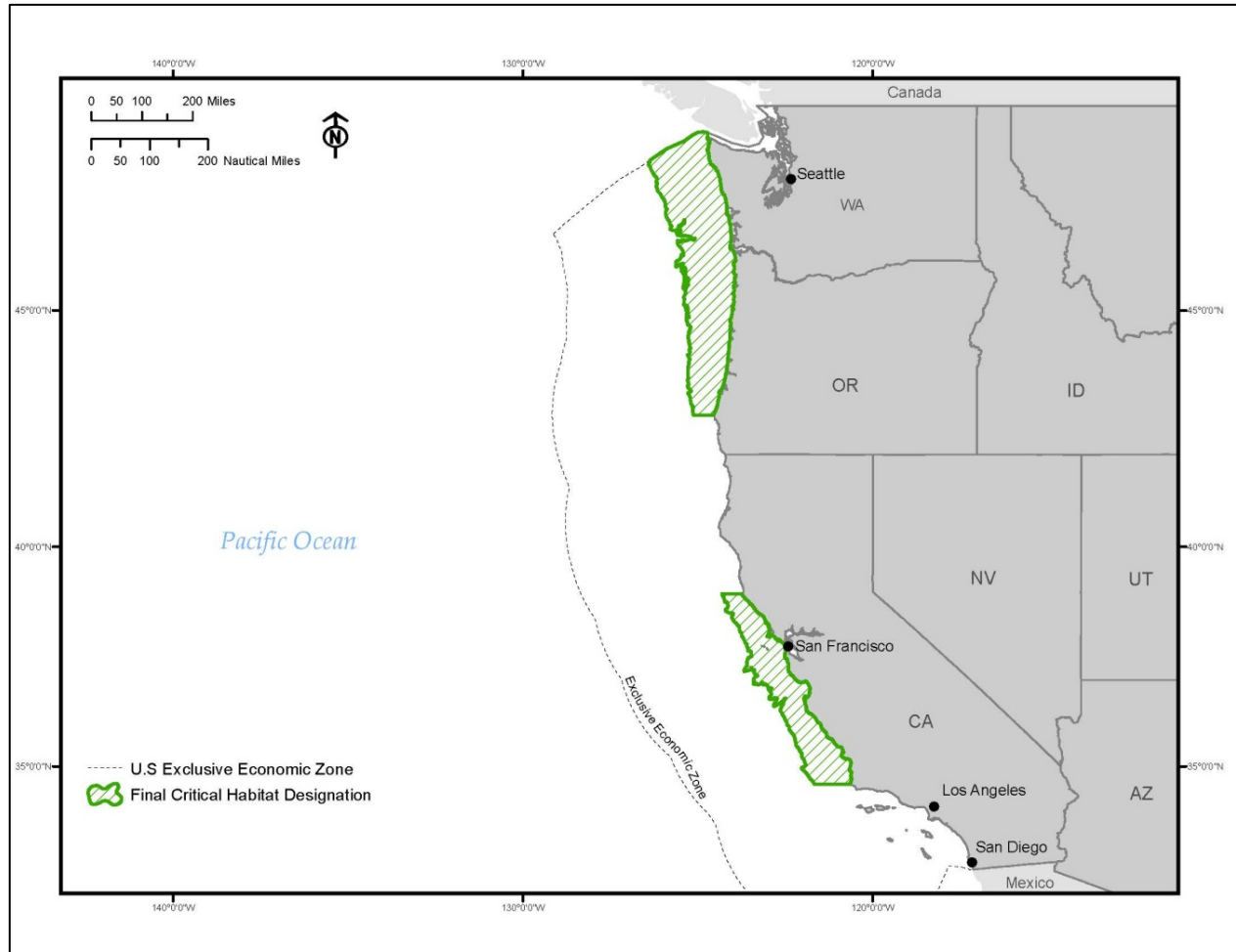


Figure 3.2-3 Designated Critical Habitat for the Leatherback Sea Turtle

In the Pacific, the IUCN notes that most leatherback nesting populations have declined more than 80 percent. In other areas of the leatherback's range, observed declines in nesting populations are not as severe, and some population trends are increasing or stable.

Declines in the leatherback population have resulted from fishery interactions as well as exploitation of the eggs (Ross 1996). Eckert and Lien (1999) and Spotila et al. (1996) reported that adult mortality has also increased significantly, particularly as a result of driftnet and longline fisheries. Zug and Parham (1996) attributed the sharp decline in leatherback populations to the combination of the loss of long-lived adults in fishery related mortality, and the lack of recruitment, stemming from elimination of annual influxes of hatchlings because of egg harvesting. Leatherbacks are also susceptible to entanglement in lobster and crab pot gear.

The first sea turtle take observed in the U.S. West Coast groundfish fishery was in 2008. A leatherback turtle was observed on an open access vessel fishing with pot gear off California in late September 2008. The turtle was found just below the surface with its flippers entangled in a buoy line, which was connected to a sablefish fish-pot. Although leatherback turtles are known to inhabit waters off of Oregon and California in summer and fall, they have been sighted only twice by West Coast observers since

September 2001. With only one data point, it is not possible to provide bycatch estimates for this species (Jannot 2011).

Olive Ridley Sea Turtle

Olive ridley sea turtles occur in the CCRA only.

Olive ridleys are globally distributed in the tropical regions of the South Atlantic, Pacific, and Indian Oceans. The olive ridley is mainly a "pelagic" sea turtle, but has been known to inhabit coastal areas, including bays and estuaries. Olive ridleys mostly breed annually and have an annual migration from pelagic foraging, to coastal breeding and nesting grounds, back to pelagic foraging. Trans-Pacific ships have observed olive ridleys over 2,400 miles (4,000 kilometers) from shore.

In the eastern Pacific, they typically occur in tropical and subtropical waters, as far south as Peru and as far north as California, but occasionally have been documented as far north as Alaska (Hodge and Wing 2000). Arribadas (massive synchronized nesting events) occur from June through December on certain beaches on the coasts of Mexico, Nicaragua, and Costa Rica and on a single beach in Panama (NOAA 2014b).

The olive ridley is omnivorous, meaning it feeds on a wide variety of food items, including algae, lobster, crabs, tunicates, mollusks, shrimp, and fish. Olive ridleys dive to depths of about 500 feet (150 meters), to forage on "benthic" invertebrates.

Degradation of nesting beaches, ongoing directed harvest, and bycatch in fisheries have all contributed to the decline of the species. According to the Marine Turtle Specialist Group of the IUCN, there has been a 50% reduction in population size since the 1960s. Although some nesting populations have increased in the past few years, the overall reduction is greater than the overall increase (NMFS and USFWS 2007).

No olive ridley sea turtles have been recorded as bycatch in the U.S. West Coast groundfish fishery (Jannot 2011).

Green Sea Turtle

Green sea turtles occur in the CCRA and may, but are unlikely to occur in the PSRA.

Green sea turtles are distributed circumglobally. In the eastern North Pacific, green turtles have been sighted from Baja California to southern Alaska, but most commonly occur from San Diego south.

Adult green turtles are unique among sea turtles in that they eat only plants; they are herbivorous, feeding primarily on seagrasses and algae.

Analyses of historic and recent abundance information by the IUCN's Marine Turtle Specialist Group indicates that extensive population declines have occurred in all major ocean basins over approximately the past 100-150 years. The group analyzed population trends at 32 index nesting sites around the world and found a 48-65% decline in the number of mature females nesting.

The principal cause of the historical, worldwide decline of the green turtle is long-term harvest of eggs and adults on nesting beaches and juveniles and adults on feeding grounds. These harvests continue in some areas of the world and compromise efforts to recover this species.

Incidental capture in fishing gear, primarily in gillnets, but also in trawls, traps and pots, longlines, and dredges is a serious ongoing source of mortality in many places around the world that also adversely affects the species' recovery. No green sea turtles have been recorded as bycatch in the U.S. West Coast groundfish fishery (Jannot 2011).

Loggerhead Sea Turtle

Loggerhead sea turtles occur in the CCRA and may, but are unlikely to, occur in the PSRA.

Loggerhead sea turtles occur throughout the temperate and tropical regions of the Pacific, Atlantic, and Indian Oceans in a wide range of habitats. These include open ocean, continental shelves, bays, lagoons, and estuaries (NMFS and USFWS 1995; Witherington et al. 2006). Loggerhead sea turtles are primarily benthic feeders, opportunistically foraging on crustaceans and mollusks (Wynne and Schwartz 1999; Witherington et al. 2006). Under certain conditions, they may also scavenge fish (NMFS and USFWS 1998d).

The loggerhead sea turtle is the most abundant of the sea turtles listed as threatened or endangered in the U.S. waters. In the eastern Pacific, loggerheads have been reported as far north as Alaska, and as far south as Chile. In the U.S., occasional sightings are reported from the coasts of Washington and Oregon, but most records are of juveniles off the coast of California.

Loggerheads face threats on both nesting beaches and in the marine environment. The greatest cause of decline and the continuing primary threat to loggerhead turtle populations worldwide is incidental capture in fishing gear, primarily in longlines and gillnets, but also in trawls, traps and pots, and dredges. Directed harvest for loggerheads still occurs in many places (e.g., the Bahamas, Cuba, and Mexico) and is a serious and continuing threat to loggerhead recovery (NOAA 2014b).

No loggerhead sea turtles have been recorded as bycatch in the U.S. West Coast groundfish fishery (Jannot 2011).

Hawksbill Sea Turtle

Hawksbill sea turtles may occur in the far southern end of the CCRA.

In the eastern Pacific hawksbills are known to occur from the Baja peninsula in Mexico south along the coast to southern Peru. There are no confirmed hawksbill sightings in recent history from the U.S. West Coast (NMFS and USFWS 1998e). As recently as 2007 the species had been considered largely extirpated in the region (Gaos et al 2010).

Hawksbills prefer coral reefs, such as those found in the Caribbean and Central America. Hawksbills feed primarily on a wide variety of sponges but also consume bryozoans, coelenterates, and mollusks. Hawksbill turtles use different habitats at different stages of their life cycle, but are most commonly associated with healthy coral reefs.

Hawksbills face threats on both nesting beaches and in the marine environment with the primary global threat to hawksbills being the loss of coral reef communities. In the Pacific, directed harvest of nesting females and eggs on the beach and hawksbills in the water is still widespread. Directed take is a major threat to hawksbills in American Samoa, Guam, the Republic of Palau, the Commonwealth of the Northern Mariana Islands, the Federated States of Micronesia, and the Republic of the Marshall Islands (NMFS and USFWS 1998e). In addition to directed harvest, increased human presence is a threat to hawksbills throughout the Pacific. In particular, increased recreational and commercial use of nesting beaches, beach camping and fires, litter and other refuse, general harassment of turtles, and loss of nesting habitat from human activities negatively impact hawksbills. Incidental capture in fishing gear (primarily in gillnets) and vessel strikes also adversely affect the species' recovery (NOAA 2014b).

No hawksbill sea turtles have been recorded as bycatch in the U.S. West Coast groundfish fishery (Jannot 2011).

3.2.5 Invertebrates

There is tremendous diversity among the marine invertebrates which inhabit the three NWFSC research areas. Marine invertebrates inhabit the water column and benthic habitats, including the continental shelf, canyons, kelp forests, and salt marshes. Marine invertebrates are an important part of the ecosystem, as prey for fish and marine mammals offshore and to birds and small mammals in bays and estuaries. Many invertebrates found in the research area are highly valuable to commercial, recreational, and subsistence fishing (e.g. oysters, clams, crabs, and shrimp), but detailed species descriptions will not be provided in this DPEA as they are not caught as target or bycatch of NWFSC affiliated research.

Within the NWFSC research area there are many species of concern, monitored by state and federal agencies; however, none have been caught by NWFSC fisheries research either as target species or as bycatch and therefore, will not be considered in this DPEA analysis.

3.2.5.1 Threatened and Endangered Species

Eight species of abalone occur in the CCRA, including white, black, green, pink, pinto, red, threaded, and flat abalone. Abalone once supported commercial and recreational fisheries in California, but overfishing and disease have prompted the listing of two species of abalone, black (*Haliotis cracherodii*) and white (*Haliotis sorenseni*), to be listed as endangered under the ESA. Three additional species of abalone (pink, green, pinto) are also part of NOAA's Species of Concern Program, which supports proactive research and conservation (NMFS 2007c).

Brief descriptions are given for each of the ESA-listed species including habitat, distribution, and factors leading to population decline. There is no history of bycatch of black or white abalone during NWFSC affiliated research cruises.

Black abalone

Black abalone occur only in the CCRA.

The black abalone is a large marine gastropod mollusk found in rocky intertidal and subtidal habitats where the bedrock provides deep crevices for shelter. The range of the black abalone is from about Point Arena in northern California to Bahia Tortugas and Isla Guadalupe, Mexico. They are rare north of San Francisco and south of Punta Eugenia. The black abalone has been listed by the ESA as endangered since January 2009. A lethal disease, withering syndrome, is thought to have caused mass mortalities of 95 percent or greater in virtually all investigated locations. The disease is most prevalent in the southern portion of the black abalone range, where the water temperature is warmer or where water temperatures are elevated by thermal discharge of power plants. Overfishing is also a primary factor leading to the decline of black abalone, which were fished intermittently from the 1950s up to their listing under the ESA in 2009. Other factors responsible for decline include illegal harvest, habitat destruction, natural predation, and competition (NMFS 2009a).

In October 2011, the NMFS designated critical habitat for the endangered black abalone under the ESA (76 FR 66806). This designation includes approximately 360 square kilometers of rocky intertidal and subtidal habitats along the California coast between the Del Mar Landing Ecological Reserve to the Palos Verdes Peninsula, from the mean higher high water (MHHW) line to a depth of 6 meters relative to the mean lower low water (MLLW) line, as well as the coastal marine waters encompassed by these areas. Critical habitat also extends offshore to the Farallon Islands, Año Nuevo Island, San Miguel Island, Santa Rosa Island, Santa Cruz Island, Anacapa Island, Santa Barbara Island, and Santa Catalina Island.

White abalone

White abalone occur only in the CCRA.

The white abalone is an herbivorous, marine, rocky benthic, broadcast spawning gastropod that is found in open low and high relief rock or boulder habitat that is interspersed with sand channels. The historic range of white abalone extended from Point Conception, California, USA, to Punta Abreojos, Baja California, Mexico. The current range is limited to along the mainland coast in Santa Barbara County and at some of the offshore islands and banks in the middle portion of the range. No recent information on current range is available for Baja California (NMFS 2008d). White abalone is currently listed as endangered throughout its range. The most significant threat to white abalone is the long-term effects that overfishing has had on the species. Commercial fisheries in California were closed in 1996, which proved to be inadequate for the recovery of the species. Based on commercial fishery data, the population of white abalone in Mexico is thought to be depleted, but the status in Mexico remains largely unknown (NMFS 2008d). This species is currently protected by the ESA and a recovery plan was finalized by USFWS in 2008. As part of the final rule listing white abalone as endangered (66 FR 29046; May 29, 2001), NMFS determined that it was not prudent to designate critical habitat, because identification of such habitat would be expected to increase the threat of poaching for this species (NMFS 2011b).

3.2.5.2 Target Species

There are more than 30 invertebrate species that are federally or state managed within the NWFSC research area, but of those, only three have been caught in NWFSC affiliated research (Table 3.2-8). Many invertebrate species are managed by a combination of federal, state, and tribal management agencies due to their high value in commercial, recreational, and traditional fisheries.

Table 3.2-8 Target Invertebrate Species

Species	Scientific Name	Fishery Management Plan	Status of the Stock
Dungeness crab	<i>Cancer magister</i>	Washington Coastal Dungeness Crab Summer FMP Pacific States Marine Fisheries Commission, Dungeness Crab Tri-State process	No stock assessment, but believed to be stable and not overfished
Market squid	<i>Loligo opalescens</i>	CDFG California Market Squid Fishery Management Plan NMFS Coastal Pelagic Species Fishery Management Plan NOAA Fisheries Pacific Fishery Management Council	No stock assessment, but believed to be stable and not overfished
Ocean pink shrimp	<i>Pandalus jordani</i>	No specific management plan. State management techniques primarily related to bycatch reduction and understanding of life history	No stock assessment, but believed to be stable and not overfished

3.2.5.3 Other Species caught in NWFSC Surveys

The invertebrate species in Table 3.2-9 represent species encountered during NWFSC research surveys.

Table 3.2-9 Other Invertebrate Species Encountered in NWFSC Research

Species	Scientific Name	Species	Scientific Name
Armhook squid	<i>Berryteuthis</i>	Octopus	<i>Octopoda (spp)</i>
Beroe spp.	<i>Beroe spp.</i>	Oval Sea Biscuit	<i>Brissopsis pacifica</i>
Brisaster spp/Brissopsis	<i>Brisaster spp/Brissopsis</i>	Penicillate jelly	<i>Polyorchis penicillatus</i>
Brown Box Crab	<i>Lopholithodes foraminatus</i>	Pineapple Benthic	<i>Dromalia alexandri</i>
Brownbanded moon jelly	<i>Aurelia limbata</i>	Pink shrimp	<i>Pandalus jordani</i>
California armhook squid	<i>Gonatus californiensis</i>	Pink Sun Star	<i>Heterozonias alternatus</i>
California Cucumber	<i>Parastichopus californicus</i>	Pom Pom Anemone	<i>Liponema brevicornis</i>
California Sea Slug	<i>Pleurobranchaea</i>	Pteropod	<i>Cavoliniidae</i>
Carpet Star	<i>Thrissacanthias penicillatus</i>	Purple Sea Potato	<i>Molpadia intermedia</i>
Comb jellies (unident.)	<i>Ctenophora</i>	Red rock crab	<i>Cancer productus</i>
Crab	<i>Brachyura</i>	Red Star	<i>Myxoderma platyacanthum</i>
Crab spp.	<i>Cancer</i>	Rough Anemone	<i>Paractinostola faeculenta</i>
Crangon shrimp	<i>Crangon</i>	Salp spp.	<i>Salpidae</i>
Cross jelly	<i>Mitrocoma cellularia</i>	Sandy Sea Cucumber	<i>Pseudostichopus mollis</i>
Deep-sea Sunflower Star	<i>Rathbunaster californicus</i>	Sea butterfly	<i>Corolla spectabilis</i>
Edible blue mussel	<i>Mytilus edulis</i>	Sea gooseberry	<i>Pleurobrachia sp.</i>
Egg yolk jelly	<i>Phacellophora camtschatica</i>	Sea nettle	<i>Chrysaora fuscens</i>
Euphausiid (krill)	<i>Euphausiidae</i>	Sea Pigs	<i>Scotoplanes spp.</i>
Flapjack Devilfish	<i>Opisthoteuthis californiana</i>	Sea snails	<i>Carinariidae</i>
Flat mud star	<i>Luidia foliolata</i>	Sea snails	<i>Limacinidae</i>
Fragile red sea urchin	<i>Allocentrotus fragilis</i>	Sea urchins and sand dollars unident.	<i>Echinoidea</i>
Gammarid amphipod	<i>Gammaridae</i>	Sergestid shrimp	<i>Sergestidae</i>
Giant Anemone	<i>Metridium farcimen</i>	Shrimp	<i>Caridea</i>
Giant Mud Urchin	<i>Brisaster townsendi</i>	Sidestripe shrimp	<i>Echinoidea</i>
Giant Sea Biscuit	<i>Spatangus californicus</i>	Slender Star	<i>Zoroaster evermanni</i>
Giant Soft Cucumber	<i>Parastichopus leukothele</i>	Sponge unident.	<i>Porifera</i>
Grooved Tanner Crab	<i>Chionoecetes tanneri</i>	Spot shrimp	<i>Pandalus platyceros</i>
Helmet jellyfish	<i>Periphylla periphylla</i>	Squat lobster	<i>Munida quadrispina</i>
Hormiphora cucumis	<i>Hormiphora cucumis</i>	Squid (unident.)	<i>Teuthoidea</i>
Humboldt Squid	<i>Dosidicus gigas</i>	Sunflower Star	<i>Pycnopodia helianthoides</i>
Jellyfish (unident.)	<i>Scyphozoa</i>	Thysanoessa spinifera	<i>Thysanoessa spinifera</i>
Lion's mane jelly	<i>Cyanea capillata</i>	Urchin Spp.	<i>Brisaster spp.</i>
Long-slit Serpent Star	<i>Asteronyx longifissus</i>	Water jelly	<i>Aequorea spp.</i>
Minimal armhook squid	<i>Berryteuthis anonychus</i>		<i>Hexactinosida</i>
Moon jelly	<i>Aurelia spp.</i>		<i>Neptunea spp.</i>
Mud Urchin	<i>Brisaster latifrons</i>		<i>Rossellinae</i>
Northern kelp crab	<i>Pugettia producta</i>		<i>Benthoctopus spp.</i>

3.2.5.4 Corals

Corals provide habitat for other marine life, increase habitat complexity, and contribute to marine biodiversity. Several coral taxa in the region are designated as structure and habitat-forming, meaning they are known to provide vertical structure above the sea floor, which can be utilized by other invertebrates or fish (Whitmire and Clarke 2007).

- A. Stony corals (Class Anthozoa, Order Scleractinia) - include 18 species from seven families.
- B. Black corals (Class Anthozoa, Order Antipatharia) - abundant, but not very speciose, with seven species from three families.
- C. Gold corals (Class Anthozoa, Order Zoanthidea) - rare, with only one unconfirmed record.
- D. Gorgonians (Class Anthozoa, Order Gorgonacea) - most speciose group of corals off the Pacific coast with 36 species from 10 families.
- E. True soft corals (Class Anthozoa, Order Alcyonacea) - eight species from three families occur off the Pacific coast.
- F. Pennatulaceans (Class Anthozoa, Order Pennatulacea) - most abundant coral taxon in the region.
- G. Sylasterid corals (Class Hydrozoa, Order Anthoathecatae, Suborder Filifera) - lace corals off the Pacific coast, observed colonizing rocky habitats from the intertidal zone to shelf water depths. Five species from three genera are known to occur in the region (Fisher 1938, Cairns 1983, Whitmire and Clarke 2007).

The overall distribution and species composition of these deep-water coral communities remain poorly understood, but anecdotal data suggest that deep corals have become less common due to the impacts of bottom fishing. Deep corals are especially susceptible to damage by fishing gear because of their often fragile, complex, branching form of growth and slow growth rates (Lazier et al. 1999). In 2010, NOAA completed a Strategic Plan for Deep-Sea Coral and Sponge Ecosystems: Research, Management, and International Cooperation (NOAA 2010a) that identifies goals, objectives, and approaches to guide NOAA's research, management, and international cooperation activities on deep-sea coral and sponge ecosystems through 2019. To better understand the biodiversity of these corals, the NWFSC Molecular Genetics group is engaged in collaborative research to develop a collection of specimens associated with a library of genetic markers that can be used for species identification and examination of population structure (NMFS 2014b).

3.3 SOCIAL AND ECONOMIC ENVIRONMENT

Activities associated with the intent and implementation of fisheries research have several implications for the social and economic environment. These include providing guidance for federally managed commercial, recreational, and subsistence fisheries, and direct and indirect expenditures on goods and services associated with fisheries research.

NWFSC research is conducted in the CCRA from California to Southeast Alaska but most research activities occur primarily off the Oregon and Washington coasts. Activities in the region influence communities in Washington, Oregon, and California. Research activities are also conducted by the Southwest Fisheries Science Center, which concentrates in waters off the California Coast. There are complex economic and demographic interactions with United States ports in other research areas, especially the Northern Pacific Region (Alaska).

NWFSC research is used for stock assessments that provide the Regional Fishery Management Councils and NOAA with the scientific information needed to implement the Magnuson-Stevens Fishery Conservation and Management Act (MSA) requirement for annual catch limits that prevent overfishing, rebuild overfished stocks, and obtain optimum yield from the fisheries. The goal is to achieve fish harvests that provide the greatest overall benefit to the national economy, particularly with respect to food production and recreational opportunities, and taking into account the protection of marine ecosystems.

The 1996 amendments to the MSA require assessment, specification, and description of the effects of conservation and management measures on participants in fisheries, and on fishing communities (NMFS 2009b). The MSA states:

Conservation and management measures shall, consistent with the conservation requirements of this Act (including the prevention of overfishing and rebuilding of overfished stocks), take into account the importance of fishery resources to fishing communities in order to (A) provide for the sustained participation of such communities, and (B) to the extent practicable, minimize adverse economic impacts on such communities.

The NMFS Economics Program monitors status and trends in performance of the commercial and recreational fishing sectors, including assessing regional economic impacts (sales, value-added, and job impacts). The NMFS Human Dimensions Program conducts community studies and develops statistical methodologies and economic models for identifying and describing communities substantially engaged in fishing. This information is ultimately used by fishery managers, whose decisions balance the needs of a variety of fishing communities and users.

NMFS provides an annual report, Fisheries Economics of the United States (NMFS 2014c), which provides an annual analysis of states' economic participation in fisheries. NMFS also provides Fishing Communities of the United States (NMFS 2009b) which estimates community engagement and dependence on managed fisheries. Factors included in the estimations are commercial market conditions, recreational fishing expenditures and levels of participation, key species, and community profiles. The profiles are developed with data about the home ports of vessels participating in a particular fishery, the residence of commercial or recreational fishing participants, port landings, and the location of processing and service facilities.

3.3.1 Commercial Fisheries

Fisheries Economics of the United States 2012 analyzed commercial fisheries data for 2012 (NMFS 2014c). Key commercial species for the Pacific region (Washington, Oregon, California) include albacore tuna, crab, flatfish, hake, rockfish, sablefish, salmon, shrimp, squid, and other shellfish. These species and species groups accounted for 92 percent of total commercial fishing revenue in the region between 2003 and 2012. Hake and squid had the highest annual landings in the Pacific Region in 2012, with 347 million

pounds and 215 million pounds, respectively. Together, they accounted for 53 percent of the total landings in the Pacific Region, but only accounted for 17 percent of the total landings revenue generated in 2012 (NMFS 2014d). Table 3.3-1 shows landings and revenue data for Washington, Oregon, and California from 2008 to 2012.

Table 3.3-1 Commercial Landings, Revenue, and Top Species (by Weight) for Washington, Oregon, and California, 2008-2012

All Species			Top Species, by Weight				Top Species Percent of All Species (Pounds)	Top Species Percent of All Species (Revenue)
	Pounds	Revenue	Pounds	Revenue	Price per Pounds	Top Species		
WASHINGTON								
2008	173,176,427	\$232,841,042	67,158,518	\$7,249,021	\$0.11	Pacific hake	38.78%	3.11%
2009	163,937,071	\$227,773,331	36,378,355	\$2,333,951	\$0.06	Pacific hake	22.19%	1.02%
2010	189,486,419	\$255,332,411	58,899,671	\$4,104,643	\$0.07	Pacific hake	31.08%	1.61%
2011	210,671,556	\$331,403,929	73,493,556	\$7,182,902	\$0.10	Pacific hake	34.89%	2.17%
2012	13,578,312	\$275,585,270	78,136,000	\$7,889,599	\$0.10	Pacific sardine	36.58%	2.86%
OREGON								
2008	195,688,351	\$103,042,323	55,510,987	\$6,829,815	\$0.12	Pacific hake	28.37%	6.63%
2009	198,894,579	\$104,706,112	53,466,222	\$3,782,855	\$0.07	Pacific hake	26.88%	3.61%
2010	201,478,532	\$104,653,225	57,016,705	\$5,413,957	\$0.09	Pacific hake	28.30%	5.17%
2011	274,525,370	\$148,336,967	142,091,739	\$16,517,516	\$0.12	Pacific hake	51.76%	11.14%
2012	295,892,198	\$128,030,241	102,650,523	\$14,610,529	\$0.14	Pacific hake	34.69%	11.41%
CALIFORNIA								
2008	323,884,364	\$120,860,944	126,944,832	\$7,575,420	\$0.06	Pacific sardine	39.19%	6.27%
2009	373,369,978	\$150,382,503	203,866,868	\$56,524,336	\$0.28	California market squid	54.60%	37.59%
2010	437,847,156	\$176,251,640	288,473,947	\$71,160,036	\$0.25	California market squid	65.88%	40.40%
2011	408,137,283	\$201,155,416	267,983,047	\$66,567,098	\$0.25	California market squid	65.66%	33.09%
2012	352,863,270	\$231,459,903	214,861,518	\$63,883,456	\$0.30	California market squid	60.09%	27.60%

Source: (NMFS 2014d)

In 2012, California had the largest number of jobs supported by the seafood industry (145,433) and the highest sales impacts generated by the seafood industry (\$24 billion) in the United States. Washington had the fourth largest number of jobs (60,955) nationwide, and was fifth in annual sales impacts (\$7.5 billion). Oregon seafood industry supported jobs were estimated at 16,051 (NMFS 2014e). Washington

had the highest landings revenue in the Pacific region with \$276 million. California (\$232 million) and Oregon (\$128 million) followed. California contributed the most pounds landed in the region (354 million pounds), followed by Oregon (296 million pounds) and Washington (214 million pounds). In 2012, commercial fishers in the Pacific region landed 1.1 billion pounds of finfish and shellfish. This was a 7.5 percent increase from 2003 and a 9.1 percent decrease from 2011 (NMFS 2014e).

Landings revenue in Washington, Oregon, and California totaled \$662 million in 2012. This was a 56 percent increase (a 12 percent increase in real terms) from 2003 levels (\$423 million) and a 6.6 percent decrease (a 6.2 percent decrease in real terms) relative to 2011 (\$709 million) (NMFS 2014e).

Ports collecting the most revenue for landed fish and shellfish in the region from 2003 to 2012 were: Los Angeles and Port Hueneme-Oxnard-Ventura, California; Astoria and Newport, Oregon; and Westport, Washington (NMFS 2011c). Table 3.3-2 shows landings data by port.

Table 3.3-2 Top Landings Locations in Washington, Oregon, and California 2003-2012

Year	U.S. Rank (by Dollars)	Port	Millions of Pounds	Millions of Dollars
2003	9	Astoria, OR	114.1	\$25.60
	12	Los Angeles, CA	88.7	\$16.50
2004	9	Astoria, OR	135.8	\$19.90
	11	Newport, OR	111.2	\$29.60
2005	9	Los Angeles, CA	139.7	\$26.60
	11	Westport, WA	122.8	\$36.70
2006	8	Los Angeles, CA	164.5	\$30.20
	9	Astoria, OR	164.2	\$33.00
2007	10	Los Angeles, CA	141.3	\$18.70
	11	Westport, WA	120	\$32.00
2008	9	Los Angeles, CA	123.6	\$22.70
	11	Westport, WA	111.1	\$43.40
2009	9	Port Hueneme-Oxnard-Ventura, CA	141.3	\$42.70
	11	Westport, WA	111.1	\$43.40
2010	7	Los Angeles, CA	186.8	\$37.80
	14	Astoria, OR	100.9	\$30.50
2011	18	Westport, WA	116.3	\$61.00
	25	Astoria, OR	143.8	\$44.40
2012	16	Westport, WA	133.4	\$58.90
	24	Los Angeles, CA	161.9	\$43.60

Source: (NMFS 2011c)

3.3.2 Recreational Fisheries

In 2012, almost 1.6 million recreational anglers fished in 7.4 million trips in the Pacific Region. Over 72 percent of these anglers were residents of a coastal county. The total saltwater fishing trip and durable equipment expenditures were \$1.8 billion across the Pacific Region in 2012. Approximately 64 percent of these expenditures were related to durable equipment purchases (NMFS 2014c).

NMFS estimates recreational fishing data, based on a variety of sources. For the U.S. West Coast, data is partially derived from mail and phone surveys, with contacts sampled from saltwater and freshwater fishing licenses. NMFS uses an input-output economic model to generate different metrics for assessing the contributions to a region's economy from expenditures on marine recreational fishing. (Lovell et al. 2013).

Lovell et al. (2013) estimated the economic effects of recreational fishing sales at the state level for 2011, shown in Table 3.3-3.

Table 3.3-3 Total Economic Impacts Generated from Marine Recreational Fishing, by State, in 2011

	Expense (\$1,000)	Economic Contribution				Taxes (\$1,000)
		Employment (Jobs)	Income (\$1,000)	Value Added (\$1,000)	Output (\$1,000)	
Washington	\$460,330	5,093	\$246,678	\$389,952	\$653,972	\$102,633
Oregon	\$254,004	2,799	\$119,662	\$188,069	\$308,602	\$55,333
California	\$923,393	10,111	\$526,496	\$843,652	\$1,430,919	\$244,816

Source: (Lovell et al. 2013)

Key Pacific Region recreational species and species groups include albacore and other tunas; barracuda, bass, and bonito; croakers; flatfishes; greenlings; mackerel; rockfishes and scorpionfishes; salmon; sculpins; and surfperches. The species and species groups caught most frequently in the Pacific Region in 2012 were rockfishes and scorpionfishes (4.3 million fish), surfperches (2.4 million fish), mackerel (1.2 million fish), and barracuda, bass, and bonito (1.1 million fish) in 2012. Between 2003 and 2012, key species or groups with the largest decreases in catch totals were barracuda, bass and bonito (80 percent), croakers (70 percent), and greenlings (58 percent) (NMFS 2014c).

3.3.3 Fishing Communities

In 2000, 1,004 communities in the U.S. had economic interaction with Pacific coast fisheries, as evidenced by fishing permits, vessel registrations, location of landings, and seafood processing plants. NMFS has identified and profiled 125 fishing ports on the U.S. West Coast with significant engagement in commercial and/or recreational fisheries (Norman et al. 2007). They were primarily selected because of pounds and value of commercial fish landed, and vessel statistics. As shown in Figure 3.3-1, they include 53 communities in California, 32 in Oregon, and 40 in Washington. Many are home ports for fishing vessels that spend part of the year fishing in Alaska, evident in that they hold both Pacific and North Pacific fishing permits (NMFS 2009b).

Each community profile contains a description of people and place, infrastructure, and economic involvement in the fisheries. The 2000 median population for the top fishing communities combined was 84,038. The communities tend to be smaller in population, though some large cities, such as Los Angeles and Seattle, dominate because of centralized vessel services and fish processing facilities located there (NMFS 2009b). Fifty-five percent of Washington's profiled communities had a population less than 5,000. Correspondingly, 71 percent of Oregon and 27 percent of California communities also had populations less than 5,000 (Norman et al. 2007).

NMFS estimated economic indicators for fishing communities, based largely on 2000 U.S. Census data (NMFS 2009b). However, economic indicators have changed since 2000. For example, in 2000, state unemployment percentages were 5.0 in California, 4.7 in Washington, and 5.0 in Oregon. By 2011,

unemployment rates rose to 12.4, 9.2, and 10.4 percent, respectively, more than doubling in California and Oregon. Nationwide, 2014 unemployment in the Agriculture, Forestry, Fishing and Hunting sector was almost double that of unemployment overall, at 12 percent (USDOL 2014).

In 2000, the percentage of California households below the poverty level was 10.6. Most of California fishing communities had similar rates, with the exception of Crescent City (33.7), Point Arena (24.1), and San Pedro (13.2). Oregon's poverty level rate was 7.9, and all fishing communities exceeded that rate except Depoe Bay at 5.5 percent. Washington's level was 7.3 percent, with La Push and Neah Bay exceeding that at 20.0 and 26.3 percent, respectively (NMFS 2009b).

3.3.3.1 Washington Fishing Communities:

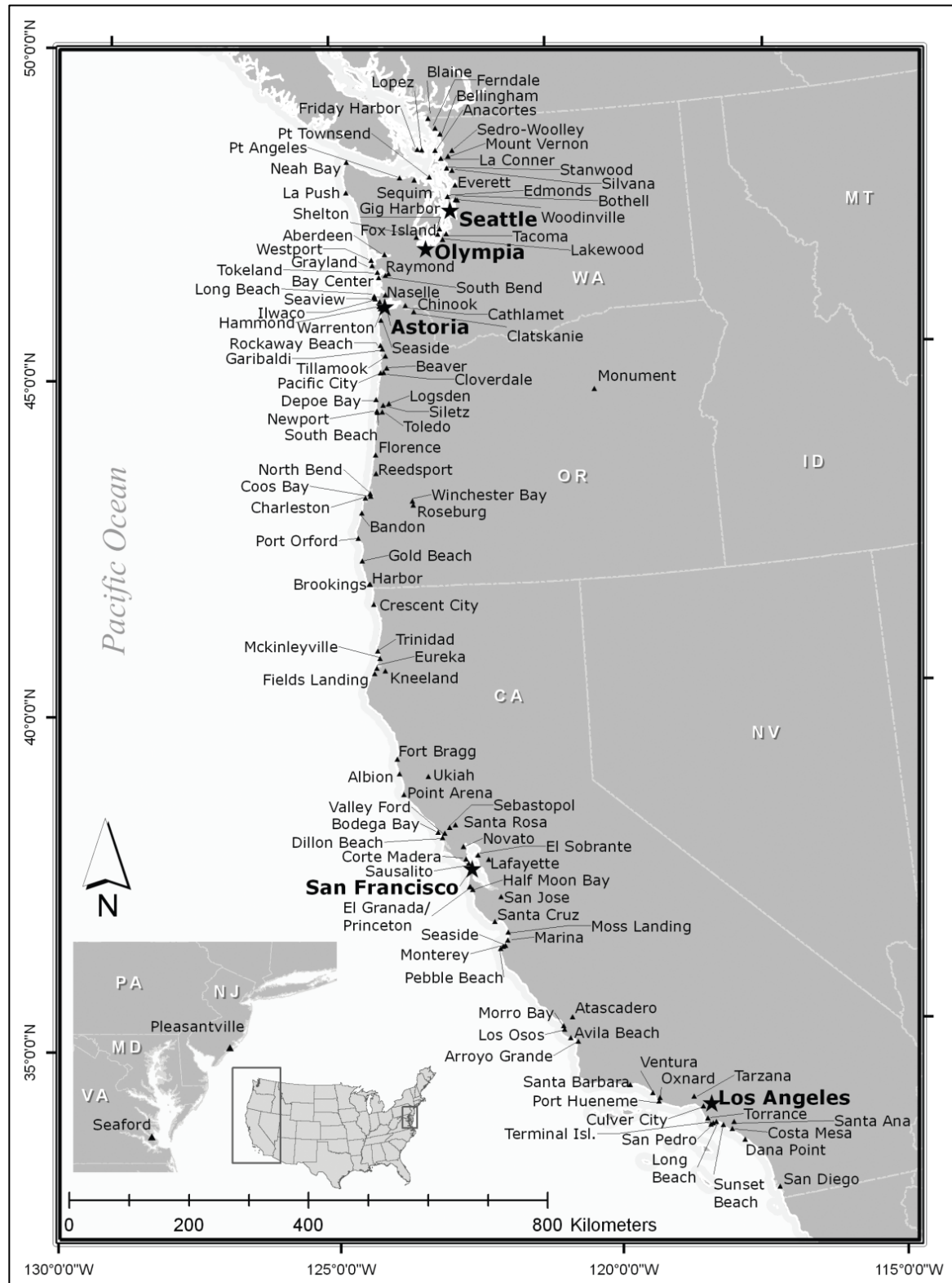
Aberdeen, Anacortes, Bay Center, Bellingham, Blaine, Bothell, Cathlamet, Chinook, Edmonds, Everett, Ferndale, Fox Island, Friday Harbor, Gig Harbor, Grayland, Ilwaco, La Conner, La Push, Lakewood, Long Beach, Lopez, Mount Vernon, Naselle, Neah Bay, Olympia, Port Angeles, Port Townsend, Raymond, Seattle, Seaview, Sedro-Woolley, Sequim, Shelton, Silvana, South Bend, Stanwood, Tacoma, Tokeland, Westport, and Woodinville.

3.3.3.2 Oregon Fishing Communities:

Astoria, Bandon, Beaver, Brookings, Charleston, Clatskanie, Cloverdale, Coos Bay, Depoe Bay, Florence, Garibaldi, Gold Beach, Hammond, Harbor, Logsdon, Monument, Newport, North Bend, Pacific City, Port Orford, Reedsport, Rockaway Beach, Roseburg, Seaside, Siletz, Sisters, South Beach, Tillamook, Toledo, Warrenton, and Winchester Bay.

3.3.3.3 California Fishing Communities:

Albion, Arroyo Grande, Atascadero, Avila Beach, Bodega Bay, Corte Madera, Costa Mesa, Crescent City, Culver City, Dana Point, Dillon Beach, El Granada, El Sobrante, Eureka, Fields Landing, Fort Bragg, Half Moon Bay, Kneeland, Lafayette, Long Beach, Los Angeles, Los Osos, Marina, McKinleyville, Monterey, Morro Bay, Moss Landing, Novato, Oxnard, Pebble Beach, Point Arena, Port Hueneme, Princeton, San Diego, San Francisco, San Jose, San Pedro, Santa Ana, Santa Barbara, Santa Cruz, Santa Rosa, Sausalito, Seaside, Sebastopol, Sunset Beach, Tarzana, Terminal Island, Torrance, Trinidad, Ukiah, Valley Ford, and Ventura.



Source: (Norman et al. 2007)

Figure 3.3-1 U.S. West Coast Fishing Communities

3.3.4 Native American Tribes

Native American tribes in the Pacific Northwest are dependent sovereign nations. Accordingly, the United States has a trust relationship with these tribes that vary depending on the underlying treaties, statutes, and agreements creating the duty. Executive Order (EO) 13175, Consultation and Coordination with Indian Tribal Governments, affirms the trust responsibility of the United States and directs agencies to consult with Native American Tribes and to respect tribal sovereignty when tribal rights may be affected. Where NWFSC actions may affect tribal lands or treaty rights, the trust duty includes a substantive duty to protect tribal rights to the fullest extent possible. In accordance, NWFSC routinely communicate with various tribal entities as activities or issues of interest arise. Tribal responses have varied from acknowledgment and declining the invitation to comment to recommendations on changes to research protocols to suggesting alternative methods or policies.

Within the Pacific Northwest region there are 39 federally-recognized Native American tribes: 29 in Washington, and 10 in Oregon (NCSL 2014). Additionally, there are another 115 federally recognized tribes in California (NCSL 2014); however, many of these tribes are not coastal and do not have direct interactions with NWFSC fisheries research activities but may have indirect interest in the research in terms of fish that are caught either migrating into or out of interior (upstream) habitats and stock assessments and health of the ecosystem research.

The following Washington, Oregon, and California federally recognized tribes may conduct activities in areas where NWFSC conducts research. The tribes are as follows:

Washington

- Confederated Tribes of the Chehalis Reservation
- Confederated Tribes of the Colville Reservation
- Confederated Tribes and Bands of the Yakama Nation
- Cowlitz Indian Tribe
- Hoh Indian Tribe of the Hoh Indian Reservation
- Jamestown S'Klallam Tribe of Washington
- Kalispel Indian Community of the Kalispel Reservation
- Lower Elwha Tribal Community of the Lower Elwha Reservation
- Lummi Tribe of the Lummi Reservation
- Makah Indian Tribe of the Makah Indian Reservation
- Muckleshoot Indian Tribe of the Muckleshoot Reservation
- Nisqually Indian Tribe of the Nisqually Reservation
- Nooksack Indian Tribe of Washington
- Port Gamble Indian Community of the Port Gamble Reservation
- Puyallup Tribe of the Puyallup Reservation
- Quileute Tribe of the Quileute Reservation
- Quinault Tribe of the Quinault Reservation
- Samish Indian Tribe

- Sauk-Suiattle Indian Tribe of Washington
- Shoalwater Bay Tribe of the Shoalwater Bay Indian Reservation
- Skokomish Indian Tribe of the Skokomish Reservation
- Snoqualmie Tribe
- Spokane Tribe of the Spokane Reservation
- Squaxin Island Tribe of the Squaxin Island Reservation
- Stillaguamish Tribe of Washington
- Suquamish Indian Tribe of the Port Madison Reservation
- Swinomish Indians of the Swinomish Reservation
- Tulalip Tribes of the Tulalip Reservation
- Upper Skagit Indian Tribe of Washington

Oregon

- Burns Paiute Tribe
- Confederated Tribes of the Coos, Lower Umpqua and Siuslaw Indians of Oregon
- Confederated Tribes of the Grand Ronde Community of Oregon
- Confederated Tribes of the Siletz Reservation
- Confederated Tribes of the Umatilla Reservation
- Confederated Tribes of the Warm Springs Reservation of Oregon
- Coquille Tribe of Oregon
- Cow Creek Band of Umpqua Indians of Oregon
- Fort McDermitt Paiute and Shoshone Tribes of the Fort McDermitt Indian Reservation (Nevada and Oregon)
- Klamath Tribes (formerly the Klamath Indian Tribe of Oregon)

California

- Tolowa Nation/Trinidad Rancheria
- Yurok Indian Reservation
- Big Lagoon Rancheria
- Cher-Ae Heights Indian Community of the Trinidad Rancheria, California
- Elk Valley Rancheria, California
- Resighini Rancheria, California
- Smith River Rancheria, California
- Wiyot Tribe (formerly the Table Bluff Rancheria), California

- Yurok Tribe, California

3.3.4.1 Tribal Fishing Rights

Tribal rights to harvest fisheries resources either on or off tribal lands have a significant influence on fisheries in the Northwest. Treaty language securing fishing, and hunting and gathering rights is not a “grant of rights (from the federal government to the Indians), but reservation of those not granted” (United States v. Winans, 25 S. Ct. 662 (1905)). Under this ruling, Native American Tribes retain rights not specifically surrendered to the United States, including fishing rights. Between 1854 and 1856, the United States negotiated five treaties - the treaties of Medicine Creek, Quinault, Neah Bay, Point Elliot, and Point No Point - with the northwest tribes to acquire great expanses of land (U.S. District Court 1974). The Treaty of Quinault River was renegotiated within one year to include omitted parties and is now known as the Treaty of Olympia. These treaties established reservations for the Sauk-Suiattle Indian Tribe, Swinomish Indians, and Jamestown S’Klallam at Port Gamble and guaranteed tribes fishing rights in common with citizens of the territory. Other reservations (particularly on the Pacific Coast of Washington) were later defined by executive orders. The treaties are collectively called the Stevens-Palmer Treaties, after Isaac I. Stevens, the governor of the Washington Territory, and Joel Palmer, the superintendent of Indian affairs for the Oregon Territory, who negotiated the treaties on behalf of the United States. These federal treaties ensured the signatory tribes the right to fish a “usual and accustomed grounds and stations,” which includes designated and non-designated tribal lands. Also in 1855, the Suquamish Tribe, the Confederated Tribes and Bands of the Yakama Nation, and several other tribes on the Columbia River System negotiated treaties that established reservations and ensured fishing rights at all usual and accustomed places.

During the 1960s, native fisherman participated in a series of protests or “fish-ins”, to protest fishing restrictions by the State of Washington and to pressure the U.S. government to recognize fishing rights granted by the Stevens-Palmer Treaties. In 1974, U.S. District Court Judge George H. Boldt issued a landmark federal court decision (United States v. Washington) that recognized that 14 western Washington Native American tribes and nations had, in their original treaties, retained for themselves, access to “usual and accustomed fishing grounds and stations.” As a result of this decision, the court determined that tribal treaty rights include the right of access to usual and accustomed fishing grounds and a right of up to 50 percent of the salmonid and steelhead that pass through or are present in a tribe’s usual and accustomed fishing grounds. The so-called “Boldt Decision” was reaffirmed by the Supreme Court in 1979 and has been used as a precedent for handling other similar treaties. Further, it was left open to have ongoing subproceeding that continue to define treaty fishing.

Following on the Boldt Decision, Federal District Court Judge Edward Rafeedie, in a subproceeding of that same United States v. Washington case, ruled in 1994 that in the Stevens-Palmer Treaties tribes had reserved harvest rights to half of all aquatic animals (shellfish and other finned fish) from all of the usual and accustomed places, except those places “staked or cultivated” by citizens – or those that were specifically set aside for non-Indian shellfish cultivation purposes. The Rafeedie Decision, as it now known, requires that tribes planning to harvest shellfish from public and private beaches must follow several time, place, and manner restrictions on harvest. In 1999 the U.S. Supreme Court refused let the Rafeedie Decision stand by declining to hear the appeal. As a result, many treaty tribes now fully participate in salmon, groundfish, and shellfish commercial fisheries, working with the state and federal agencies under fisheries co-management agreements to manage fishery resources and to protect and enhance these resources. Salmon are an important resource for the treaty tribes and provide a core symbol of tribal identity as well as being of nutritional and economic importance. However, the other marine fisheries are also of great economic significance for these treaty tribes.

In order to participate fully in co-management agreements, tribes employ their own fisheries researchers and scientists to evaluate stocks and habitats important to them. Concurrently, treaty tribes have

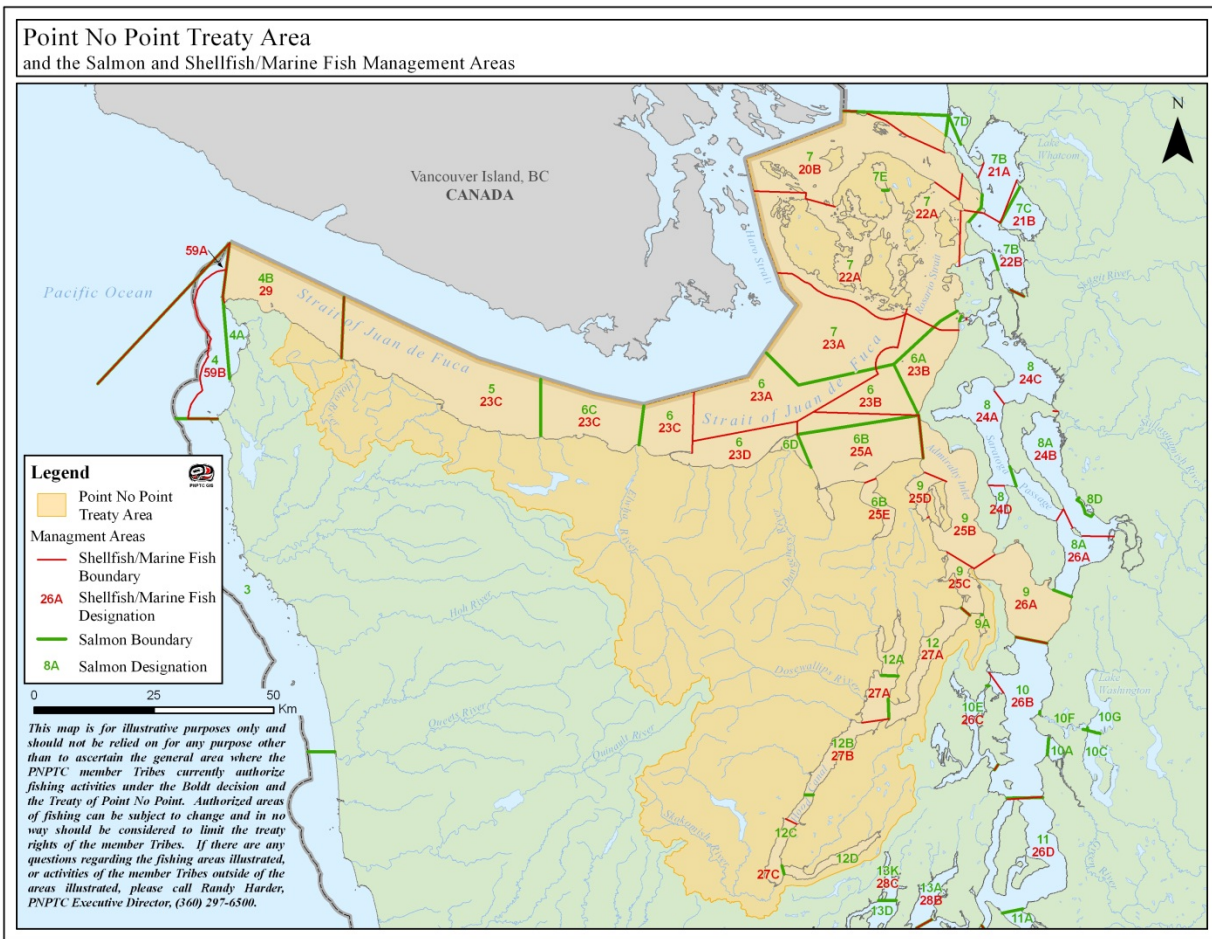
established partnerships with NMFS, the NWFSC and the Washington Department of Fish and Wildlife to manage, protect and enhance and shellfish, salmon, steelhead, and groundfish resources. Through these co-management partnerships, fisheries and habitat data as well as financial and logistical resources are often shared among all partners to enable effective co-management of fisheries resources. The NWFSC often communicates and collaborates with tribal researchers about logistical issues and share research efforts and information. Additionally, Section 302 of the MSA specifies that the Pacific Fishery Management Council include a member of a tribe with federally recognized fishing rights from California, Oregon, Washington, or Idaho. States have established technical advisory committees composed of tribal, state, and federal scientists who develop the biological information needed for fisheries management. The MSA (Section 312(a)) also establishes assistance for federally-recognized tribes that are adversely affected by federal fisheries closures and/or restrictions.

The Neah Bay Treaty, between the United States government and the Makah Tribe, is the only treaty that specifically protects the right to hunt whales (and seals). The Makah tribe traditionally hunted whales (especially gray whales *Eschrichtius robustus*), though they had not done so since the 1920's because of the whale's scarcity in the eastern Pacific. The species was listed as endangered under the ESA in 1970, and delisted in 1994. After that, The Makah requested authorization (a waiver from NMFS) to resume whale hunting, and successfully landed a whale in 1999, and hunted again in 2000 (NMFS 2008a). In 2005, the Makah tribe again requested to continue treaty right ceremonial and subsistence hunting of gray whales in its usual and accustomed fishing grounds, complying with the process prescribed in the MMPA for authorizing take of marine mammals. They also requested that NMFS take other action, such as those prescribed under the Whaling Convention Act. The NMFS conducted an Environmental Impact Statement (EIS), which was completed in 2008 (NMFS 2008b). Because of ongoing court challenges, the 2008 EIS has been terminated, and a new EIS is planned. The reason cited for this is that new scientific information regarding population substructures needs further examination (77 FR 29967, May 21, 2012).

3.3.4.2 Usual and Accustomed Fishing Areas

Each treaty tribe has a Usual and Accustomed (U&A) harvest area that reflects the historical region in which finfish, shellfish, and other natural resources were collected. Several types of U&A harvest areas have the potential to be affected by NWFSC fisheries research, including tribal marine resource gathering areas (e.g., traditional fishing areas; whaling areas; and seaweed-, mussel-, abalone-, and clam-gathering grounds). The treaties do not expressly specify the geographical extent of the harvest right; however, the courts have interpreted U&A harvest areas to include not only those lands (with their freshwater bodies) formally ceded by the tribes (described in the Treaties) but also the marine waters, where they traditionally and regularly fished during treaty times. The majority of anadromous streams and tidelands within the Northwest are within the usual and accustomed harvest areas of one or more tribe. Puget Sound, Hood Canal, the Strait of Juan de Fuca, and a major portion of the Pacific Ocean off the Washington coast lie within tribal U&As. Many U&A areas are set in smaller rivers upstream from tidewater and have the potential to be affected by activities downstream of tribal U&A areas and in marine water. Tribal members are allowed to exercise their treaty-protected harvest rights only within their tribe's U&A harvest areas. As a result, tribal members may not have the option to fish other streams or go into other areas of the open ocean, if activities have adverse impacts on fish that would otherwise travel to or from their U&A areas.

Figure 3.3-2 shows an example of treaty shellfish and marine fish harvest area boundaries, in this case as authorized under the Treaty of Point No Point and the Boldt decision.



Source: http://www.pnptc.org/images/FINAL_PNPTCKlallamFishing_052010.jpg

Figure 3.3-2 WDFW Shellfish, Marine Fish, and Salmon Management Area Boundaries and Point No Point Treaty Area

3.3.5 NWFSC Operations

The NWFSC's operations have a direct economic influence on the U.S. communities and ports in which they operate. The NWFSC's operation, headquartered in Seattle, Washington, operates primarily off the coasts and in freshwater streams (not covered under this DPEA) in Washington and Oregon. There are five research stations, located at Newport, Oregon; and Manchester, Pt. Adams, Mukilteo, and Pasco, WA.

Research-related spending directly generates jobs and income, and benefits businesses in the private economy by expenditures on research-related equipment. For research considered in this DPEA, the NWFSC carries out research in facilities located in Oregon, Washington, and California. At sea assessments can extend from off Baja California to Vancouver Island, Canada. The NWFSC's annual spending fluctuates, but has been about \$42 million in permanent federal funding in recent years (NWFSC Operations Management and Information Staff pers. comm. 2014). In addition, the Center has received about \$15 to \$18 million annually in temporary federal funding and about \$20 million in reimbursable funding from a variety of sources

The NWFSC routinely charts research vessels, commercial fishing vessels, and NOAA vessels (so called white boats) to conduct various types of fisheries research and cooperative research. From 2008

through 2010, the number of leased vessel days has ranged from 587 (2013) – 710 (2009) operating days with a total budget for this vessel related work ranging from \$6,826,000 (2013) to \$8,094,000 (2011). These totals include dollars associated with the support of research activities including operational support of NOAA vessels and chartered vessels (fuel, supplies, services), operational costs of research support facilities (utilities, supplies, services), charter fees and operating costs for all vessels, salaries for federal and contractual staff participating in fisheries research, travel, and other incidental expenses. This does not include capital costs of vessels and facilities. Cooperative Research grants and Research Set Aside programs also generate a significant amount of vessel leasing activities by external grant recipients. Fees generated from leasing contribute to the local economies and may be an important component of total income for some vessel owners.

4.1 INTRODUCTION AND ANALYSIS METHODOLOGY

This chapter presents an analysis of the potential direct and indirect effects of the alternatives on the physical, biological, and social environments consistent with Section 1502.16 of the Council on Environmental Quality (CEQ) National Environmental Policy Act (NEPA) regulations (40 Code of Federal Regulations [CFR] Part 1500) and NOAA Administrative Order 216-6 (Environmental Review Procedures for Implementing the National Environmental Policy Act). Four alternatives have been brought forward for detailed analysis (see Chapter 2):

- The No Action/Status Quo Alternative, where fisheries and ecosystem research programs conducted and funded by the Northwest Fisheries Science Center (NWFSC) would be performed as they were at the end of 2014. This is considered the No Action Alternative for ongoing programs under NEPA.
- The Preferred Alternative, where the NWFSC would conduct additional research activities and implement new protocols intended to mitigate impacts to protected species in addition to those described under the Status Quo Alternative.
- The Modified Research Alternative, where the NWFSC would conduct fisheries and ecosystem research with scope and protocols modified to minimize risks to protected species.
- The No Research Alternative, where the NWFSC would no longer conduct or fund fieldwork in marine waters for the fisheries and ecosystem research considered in the scope of this Draft Programmatic Environmental Assessment (DPEA).
- In addition to a suite of fisheries and ecological research conducted or funded by the NWFSC as the primary federal action, the Preferred Alternative and Modified Research Alternative would also include promulgation of regulations and subsequent issuance of Letters of Authorization (LOAs) under Section 101(a)(5)(A) of the Marine Mammal Protection Act (MMPA) for the incidental, but not intentional, taking of marine mammals as the secondary federal action.

As was discussed in Chapter 1 of this DPEA, the National Marine Fisheries Service (NMFS) is fundamentally a science-based agency, its primary mission being the stewardship of living marine resources through science-based management. The first three alternatives evaluated in this DPEA enable the NWFSC to collect additional scientific information that otherwise would not be fully replaced by other sources while the fourth alternative considered does not. In NMFS view, the inability to acquire scientific information essential to managing fisheries on a sustainable basis and rebuilding overfished stocks would ultimately imperil the agency's ability to meet its mandate to promote healthy fish stocks and restore the nation's fishery resources. Similar concerns apply to the conservation and management of protected species, their habitats, and other marine ecosystem components. However, there are several plausible scenarios (such as federal budget cuts, legal actions against NMFS, or natural disasters affecting NWFSC facilities) where the research activities of the NWFSC could be severely curtailed or eliminated for a period of time. The No Research Alternative therefore allows NMFS to examine the effects on the human environment of discontinuing federally funded fisheries research in the NWFSC research areas.

4.1.1 Impact Assessment Methodology

The authors of the sections in this chapter are subject matter experts. They developed a discussion of the effects on each resource component based on their best professional judgment; relying on the collective knowledge of other specialists in their respective fields and the body of accepted literature.

The impact assessment methodology consists of the following steps:

1. Review and understand the proposed action and alternatives (Chapter 2).

2. Identify and describe:
 - a. Direct effects that would be “caused by the action and occur at the same time and place” (40 CFR § 1508.8(a)), and
 - b. Indirect effects that would be “caused by the action and (would occur) later in time or farther removed in distance, but are still reasonably foreseeable” (40 CFR § 1508.8(b)).
3. Compare the impacts to the baseline conditions described in Chapter 3 and rate them as major, moderate, or minor. In order to help consistently assess impacts and support the conclusions reached, the authors developed a criteria table that defines impact ratings for the resource components (Table 4.1-1). The criteria provide guidance for the authors to place the impacts of the alternatives in an appropriate context, determine their level of intensity, and assess the likelihood that they would occur. Although some evaluation criteria have been designated based on legal or regulatory limits or requirements (see description of criteria for marine mammals below), others are based on best professional judgment and best management practices. The evaluation criteria include both quantitative and qualitative analyses, as appropriate to each resource. The authors then determine an overall rating of impacts to a given resource by combining the assessment of the impact components.

As described in Section 1.4, the reason an EA is developed is to determine whether significant environmental impacts could result from a proposed action and to inform the decision about whether an Environmental Impact Statement needs to be developed. If no significant impacts are discovered, NMFS can document its decision on the proposed action with a Finding of No Significant Impact. The assessment methodology described in this section is consistent with NOAA Administrative Order 216-6, which provides guidance on how the agency should make determinations of significance in NEPA documents.

Table 4.1-1 Criteria for Determining Effect Levels

Resource Components	Assessment Factor	Effect Level		
		Major	Moderate	Minor
Physical Environment	Magnitude or intensity	Large, acute, or obvious changes that are easily quantified	Small but measurable changes	No measurable changes
	Geographic extent	> 10% of project area (widespread)	5-10% of project area (limited)	0-5% of project area (localized)
	Frequency and duration	Chronic or constant and lasting up to several months or years (long-term)	Periodic or intermittent and lasting from several weeks to months (intermediate)	Occasional or rare and lasting less than a few weeks (short-term)
	Likelihood	Certain	Probable	Possible
Biological Environment	Magnitude or intensity	Measurably affects population trend For marine mammals, mortality and serious injury greater than or equal to 50% of PBR ¹	Population level effects may be measurable For marine mammals, mortality and serious injury between 10% and 50% of PBR	No measurable population change For marine mammals, mortality and serious injury less than or equal to 10% of PBR
	Geographic extent	Distributed across range of a population	Distributed across several areas identified to support vital life phase(s) of a population	Localized to one area identified to support vital life phase(s) of a population or non-vital areas
	Frequency and duration	Chronic or constant and lasting up to several months or years (long-term)	Periodic or intermittent and lasting from several weeks to months (intermediate)	Occasional or rare and lasting less than a few weeks (short-term)
	Likelihood	Certain	Probable	Possible
Social and Economic Environment	Magnitude or intensity	Substantial contribution to changes in economic status of region or fishing communities	Small but measurable contribution to changes in economic status of region or fishing communities	No measurable contribution to changes in economic status of region or fishing communities
	Geographic extent	Affects region (multiple states)	Affects state	Affects local area
	Frequency and duration	Chronic or constant and lasting up to several months or years (long-term)	Periodic or intermittent and lasting from several weeks to months (intermediate)	Occasional or rare and lasting less than a few weeks (short-term)
	Likelihood	Certain	Probable	Possible

1. Potential Biological Removal (PBR).

4.1.2 Impact Criteria for Marine Mammals

The impact criteria for the magnitude of effects on marine mammals have been developed in the context of two important factors derived from the MMPA. The first factor is the calculation of Potential Biological Removal (PBR) for each marine mammal stock. The MMPA defined PBR at 16 U.S.C. § 1362(20) as, "the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population." PBR was intended to serve as an upper limit guideline for commercial fishing mortality for each species. Calculations of PBR are stock-specific and include estimates of the minimum population size, reproductive potential of the species, and a recovery factor related to the conservation status of the stock (e.g., whether the stock is listed under the Endangered Species Act (ESA) or depleted under the MMPA). NMFS and USFWS are required to calculate PBR (if possible) for each stock of marine mammals they have jurisdiction over and to report PBR in the annual marine mammal stock assessment reports (SARs) mandated by the MMPA. The PBR metric is a recognized and acceptable metric used by NMFS Office of Protected Resources in the evaluation of commercial fisheries incidental takes of marine mammals in U.S. waters.

The second factor is the categorization of commercial fisheries with respect to their adverse interactions with marine mammals. Under Section 118 of the MMPA, NMFS must classify all U.S. commercial fisheries into one of three categories based on the level of marine mammal mortality and serious injury (M&SI) that occurs incidental to each fishery, which it does in the List of Fisheries (LOF) published annually. Category III fisheries are considered to have a remote likelihood of or no known incidental M&SI of marine mammals. Category II fisheries are those that have occasional incidental M&SI of marine mammals. Category I fisheries are those that have frequent incidental M&SI of marine mammals. A two-tiered classification system is used to develop the LOF, with different thresholds of incidental M&SI compared to the PBR of a given marine mammal stock.

However, the LOF criteria is primarily used for managing commercial fisheries based on their actual levels of marine mammal M&SI and is not necessarily designed to assess impacts of projected takes on a given marine mammal stock. Because the analysis of direct impacts of NWFSC research on marine mammals in this DPEA is based on projected takes rather than actual takes, we use a similar but not identical model to the LOF criteria.

In spite of some fundamental differences between most NWFSC research activities and commercial fishing practices, it is appropriate under NEPA to assess the impacts of incidental takes due to research in a manner similar to what is done for commercial fisheries for two reasons:

- NWFSC research activities are similar to many commercial fisheries in the fishing gear and types of vessels used, and
- NWFSC research plays a key role in supporting commercial fisheries.

As part of the NEPA impact assessment criteria (Table 4.1-1), if the projected annual M&SI of a marine mammal stock from all NWFSC research activities is less than or equal to 10 percent of PBR for that stock, the effect would be considered minor in magnitude for the marine mammal stock, similar to the LOF's Category III fisheries that have a remote likelihood of M&SI with marine mammals with no measurable population change. Projected annual M&SI from NWFSC research activities between 10 and 50 percent of PBR for that stock would be moderate in magnitude for the marine mammal stock, similar to the LOF's Category II fisheries that have occasional M&SI with marine mammals where population effects may be measurable. Projected annual M&SI from NWFSC research activities greater than or equal to 50 percent of PBR would be major in magnitude for the marine mammal stock, similar to the LOF's Category I fisheries that have frequent M&SI with marine mammals which measurably affect a marine mammal stock's population trend. Note that NEPA requires several other components to be considered

for impact assessments (see Table 4.1-1); the magnitude of impact is not necessarily the same as the overall impact assessment in a NEPA context.

In the MMPA LOA application, NWFSC estimated takes for each marine mammal stock are grouped by gear type (e.g., trawl gear and longline gear) with the resulting take request not apportioned by individual research activities (e.g., by survey). This precludes impact analysis at the individual activity or project level within the DPEA.

NMFS recognizes that more than one of its regional Fisheries Science Centers (FSC) may interact with the same stock of marine mammals in the Pacific, especially the NWFSC and the Southwest Fisheries Science Center (SWFSC) since they conduct research in the same California Current research area but also the Alaska FSC (AFSC) and Pacific Islands FSC (PIFSC), and that the collective impact from both of these FSCs on marine mammal stocks should be considered. The SWFSC initiated its own NEPA and MMPA compliance processes and has developed estimates of future marine mammal incidental takes. The AFSC and PIFSC have also initiated their own NEPA and MMPA compliance process but have not finalized their estimates of potential marine mammal takes yet. The historical data on incidental takes from the SWFSC and its projected takes (including species it has not taken in the past) will be considered along with the historical and projected takes of the NWFSC in the Cumulative Effects section of this DPEA (Chapter 5). NMFS does not anticipate incidental takes from SWFSC research activities to substantially increase the aggregate impacts on marine mammal stocks shared with the NWFSC. The potential cumulative effects from all overlapping FSCs will be considered when all four FSC requests for take are known.

The contribution of NWFSC research activities to overall impacts on marine mammals will be aggregated with past, present, and reasonably foreseeable future impacts on marine mammals from commercial fisheries and other factors external to NWFSC research activities in the Cumulative Effects analysis in Chapter 5. NMFS will report all sources of M&SI in the annual marine mammal stock assessment reports (SARs), including any incidental M&SI takes that may occur from any of the FSCs. The cumulative effects analysis will use the same impact assessment criteria and thresholds as described in Table 4.1-1, only they will be applied to collective sources of M&SI and other types of impacts on marine mammals.

4.2 DIRECT AND INDIRECT EFFECTS OF ALTERNATIVE 1 – NO ACTION/STATUS QUO ALTERNATIVE

This section presents an analysis of the potential direct and indirect effects of Alternative 1 – the No Action/Status Quo Alternative on the physical, biological, and social environment. Under this Alternative, fisheries research programs conducted and funded by the NWFSC would be performed as they have been in the recent past. Potential direct and indirect effects were evaluated according to the criteria described in Table 4.1-1. A summary of the impact rating determinations for all topics evaluated under Alternative 1 is presented below in Table 4.2-1.

Table 4.2-1 Alternative 1 Summary of Effects

Resource	Physical Environment	Special Resource Areas	Fish	Marine Mammals	Birds	Sea Turtles	Invertebrates	Social and Economic
Section #	4.2.1	4.2.2	4.2.3	4.2.4	4.2.5	4.2.6	4.2.7	4.2.8
Effects Conclusion	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor to Moderate <i>beneficial</i>

4.2.1 Effects on the Physical Environment

The NWFSC conducts research in three distinct areas, the California Current Research Area (CCRA), Puget Sound Research Area (PSRA), and the Lower Columbia River Research Area (LCRRA). This section describes effects on the physical environment that would result from NWFSC research activities in these three areas under Alternative 1. The potential effects of fisheries research activities on the physical environment would vary depending on the types of survey gear and other equipment used, but would generally include:

- Physical damage to benthic (seafloor) habitat
- Changes in water quality

4.2.1.1 Physical Damage to Benthic (Seafloor) Habitat

Physical impacts to seafloor habitat would be principally limited to the groundfish surveys, hake acoustic surveys, and Bycatch Reduction surveys which are the only NWFSC research surveys where bottom-contact trawl equipment is used (see Table 2.2-1).

Fishing gear that contacts the seafloor can physically damage seafloor habitat. Physical damage may include furrowing and smoothing of the seafloor as well as the displacement of rocks and boulders, and such damage can increase with multiple contacts in the same area (Morgan and Chuenpagdee 2003; Stevenson et al. 2004). Other survey equipment that contacts the seafloor, such as sensors and samplers, could cause localized physical damage to benthic habitats; but the effects of such equipment on benthic habitat would be limited to a very small area because this equipment is not usually dragged along the seafloor.

In general, physical damage to the seafloor recovers within 18 months through the action of water currents and natural sedimentation, with the exception of rocks and boulders which may be permanently displaced (Stevenson et al. 2004). Seafloor composition is highly variable both within and between the NWFSC research areas. Silt, sand, clay, and gravel are abundant at particular sites within each research

area. With the exception of rock and boulder displacement, any physical impacts to benthic habitat resulting from NWFSC survey activities would be expected to recover within 18 months.

The area of benthic habitat affected by NWFSC research each year would be a very small fraction of the total of the research areas. The Groundfish Bottom Trawl Survey (GBTS) is a comprehensive coastwide survey that extends from the U.S./Mexico border to the U.S./Canada border, an area covering almost 134,000 square kilometers. Approximately 750 survey stations are selected annually using a stratified random sampling design. Survey personnel use echosounders to survey bottom conditions prior to trawling and move or abandon stations that are untrawlable because of rough bottom, shipwrecks, or other obstacles. The portion of the trawl net that contacts the sea floor is about 15 meters wide. Nominal tows occur at 2.2 knots for 15 minutes, although variations occur due to sea state, tidal currents, and other factors. The NWFSC has calculated that the average area of benthic habitat impacted by bottom trawls in the CCRA from 2003 through 2013 was 12.02 square kilometers per year. This annual swept area represents about 0.009 percent of the total CCRA survey area. These swept areas have minimal impact on high-relief areas favored by fragile species such as corals because such areas would be avoided as untrawlable habitat.

Bottom-contact fishing gear can also increase turbidity and alter the chemical composition of water near the seafloor. However, these effects would be short-term, minor in magnitude, and limited in areal extent. Considering the small area affected and the limited magnitude of the physical effects, the overall effects of surveys on benthic habitat in each of the NWFSC research areas would be minor adverse.

4.2.1.2 Changes in Water Quality

Fishing gear that contacts the seafloor could increase the turbidity of the water by resuspending fine sediments and benthic algae from the seafloor. Resuspension of fine sediments and turnover of sediment could also result in localized increases in the concentrations of dissolved organic material, nutrients, and trace metals in seawater near the seafloor (Stevenson et al. 2004).

Several areas of known contamination from historic ocean dumping exist within the areas where NWFSC fisheries research activities are conducted, including at least one known radioactive dump site. The NWFSC has removed these known dump sites from the grid of areas open to potential bottom trawl surveys (Appendix E) and does not trawl in these areas.

Potentially adverse effects to benthic habitat resulting from discharge of contaminants from vessels used during research surveys are possible, but unlikely. If such effects were to occur, they would be infrequent, temporary, and localized. All NOAA and ocean going vessels are subject to the regulations of MARPOL 73/78, the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 (NOAA 2010b). MARPOL includes six Annexes that cover discharge of oil, noxious liquid substances, harmful packaged substances, sewage, garbage, and air pollution (International Maritime Organization IMO 2010). Adherence to these regulations minimizes or negates the likelihood of discharges of potentially harmful substances into the marine environment. Annex V specifically prohibits plastic disposal anywhere at sea and severely restricts discharge of other garbage (IMO 2010). NOAA vessels are fully equipped to respond to emergencies, including fuel spills, and crew receive extensive safety and emergency response training. These precautionary measures help reduce the likelihood of fuel spills occurring and increase the chance that they will be responded to and contained quickly. Oil spill prevention training and equipment may be more variable on commercial fishing vessels used in cooperative research although all vessels are required to comply with U.S. Coast Guard regulations on spills. Potential effects on the physical environment resulting from discharged or spilled materials are not gear type dependent and would be minor to negligible throughout the NWFSC research areas.

4.2.1.3 Conclusion

The effects of the Status Quo Alternative on the physical environment include potential changes to the benthic environment and changes in water quality. The geographic extent of any physical contact with benthic habitats caused by NWFSC fisheries research activities would be much less than one percent of the NWFSC research area and therefore considered minor in magnitude. These effects would certainly occur under the Status Quo Alternative but the duration of such effects would be temporary or short-term. Adverse effects on water quality through accidental contamination from research activities are possible, but unlikely. If such effects were to occur, their intensity, extent, duration, and frequency would be minor.

The overall effects of the Status Quo Alternative on the physical environment would be minor in magnitude, dispersed over a large geographic area, and temporary or short-term in duration, and would therefore be considered minor adverse according to the impact criteria in Table 4.1-1.

4.2.2 Effects on Special Resource Areas

Section 3.1.2 describes the special resource areas that occur in the same geographic areas as the NWFSC fishery research activities. This section describes the general types of effects that NWFSC fishery research activities may have on the following categories of special resource areas:

- Essential Fish Habitat (EFH) and Closed Areas (EFHCA)
- Marine Protected Areas (MPAs) and National Marine Sanctuaries (NMS).

4.2.2.1 Essential Fish Habitat and Closed Areas

Section 3.1.2.1 describes the areas designated as EFH and EFHCA within the NWFSC research areas. Overlapping EFH for numerous federally-managed species, including over 82 species covered by the Pacific Coast Groundfish FMP, exist within NWFSC research areas (Pacific Fishery Management Council [PFMC] 2008). The PFMC has established seasonal and year-round areas closed to all fishing gear and specific to trawl gear within EFH in the CCRA (Figure 3.1-6). NMFS has not designated closed areas within the PSRA or the LCRRA. The types of marine areas closed to fishing by federal regulation are categorized by fishing type, and are listed in Section 3.1.2.3.

The states of California, Oregon, and Washington established additional closed areas within state waters. The seasonal and year-round areas closed to fishing within the PSRA (see Section 3.1.2.4) established by the Washington Department of Fish and Wildlife are herein considered MPAs and included in Section 4.2.2.3. Closed areas designated by the Oregon Department of Fish and Wildlife also exist in the LCRRA. The NWFSC does not, however, use bottom trawls that would disturb benthic habitat in the Columbia River. The PSRA and the LCRRA will, therefore, not be further discussed in this section.

California Current Research Area

The types of effects on EFH and EFHCA resulting from NWFSC research primarily involve impacts to benthic habitat and the removal of fish and invertebrates during the Groundfish Bottom Trawl Survey (GBTS) in the CCRA. The GBTS is a comprehensive coastwide survey that extends from the U.S./Mexico border to the U.S./Canada border, an area covering almost 134,000 square kilometers. Bottom trawl data, including that collected within EFHCA, are used to inform measures of ecosystem status, stock assessments, spatial analyses, habitat and abundance linkages, and may help to inform and monitor designated EFH areas. The survey area is based on a grid comprised of nearly 13,000 cells (1.5 x 2.0 nautical miles each) along the entire U.S. West Coast, across depths ranging from 55-1,208 meters (Bradburn et al. 2011). Cells are stratified by depth and location; the cells to be sampled (survey stations) are selected annually using a stratified random sampling design. About 11 percent of cells are currently excluded from selection as survey stations due to safety issues (shipping lanes, pipelines, underwater

cables, chemical waste sites, and moorings), military ranges, radioactive dump sites, the California cowcod conservation area, and certain federal and state protected areas (Appendix E). Survey personnel may also designate cells as untrawlable because of rough bottom, shipwrecks, or other obstacles. Each randomly selected cell is searched for trawlable bottom within the designated depth range and a standard 15-minute tow is made once an acceptable sample site is found.

The GBTS area includes EFHCA that covers about 17,627 square kilometers (13.2 percent of the total survey area). GBTS stations may be completely contained within EFHCA, have some portion of the cell within EFHCA, or be completely outside EFHCA. Tows within cells that partially intersect EFHCA could occur in either the portion of the cell inside or outside of the closed area. The proportion of GBTS tows conducted within EFHCA is relatively small. Of the 7,689 tows conducted from 2003, when the current protocols were implemented, through 2013, 761 were within EFHCA (9.9%). The total area of benthic habitat affected by GBTS bottom trawls is also relatively small. The portion of the trawl net that contacts the sea floor is about 15 meters wide. Nominal tows occur at 2.2 knots for 15 minutes, although variations occur due to sea state, tidal currents, and other factors. The NWFSC has calculated that the average area of benthic habitat impacted by bottom trawls in EFHCA from 2003 through 2013 was 1.19 square kilometers per year. This annual swept area represents about 0.007 percent of the total EFHCA area. These swept areas have minimal impact on high-relief areas favored by fragile species such as corals because such areas would frequently be avoided as untrawlable habitat.

The amounts of fish and invertebrate biomass removed from EFHCA are relatively small. Tables 4.2-2 and 4.2-3 show average annual biomass removal of fish and invertebrates from survey stations at least partly within EFHCA during 2003-2013. The tables only list species with annual average catches greater than 100 kg. These average biomass removal levels cannot be compared to commercial fisheries harvests as is done in the overall analysis of effects on fish (see Section 4.2.3) because commercial bottom trawling is prohibited in EFHCA. There are also no stock assessments for fish species that pertain to just EFHCA areas for comparison. However, the NWFSC considers the average removal of all species from EFHCA to be very small compared to likely population levels.

Samples collected within EFHCA during the GBTS provide important data, particularly for stock assessments, for species managed under the Groundfish FMP and other FMPs. Including EFHCA in groundfish research surveys captures variability in species distribution, density, and habitat use that may be related to the absence of commercial bottom trawling in these areas. Tables 4.2-2 and 4.2-3 compare average catches within EFHCA-related survey stations to average annual research catch in all GBTS stations. The proportion taken within EFHCA is highly variable, ranging from 4.5% for spiny dogfish to 55.8% of total research catch for pygmy rockfish. Given that only 13.2 percent of the GBTS survey area intersects EFHCA, species with higher percentages of catch within closed areas (e.g., pygmy rockfish and Pacific grenadier) may be those with higher densities within EFHCA. For most species, density differs inside and outside of closed areas and EFHCA-related areas are places with occasional high catch rates. This could be due to several factors, from habitat differences to the absence of commercial fishing takes in those areas.

Eliminating EFHCA from trawl surveys would introduce biases in survey results for the numerous species for which density differs inside and outside of closed areas. Indices calculated without EFHCA-related tows may be misleading and could lead to inappropriate fishery management decisions about optimal yield in areas open to commercial fisheries.

Table 4.2-2 Average Annual Fish Catch within Essential Fish Habitat Closed Areas by NWFSC Groundfish Bottom Trawl Surveys, 2003-2013.

Catch from within EFHCA-related stations is shown as average annual catch (kg) and as percent of total annual fish catch, by species, from all GBTS stations, inside and outside of EFHCA. Only species with an average annual catch totaling > 100 kg are shown. Species are listed in decreasing order of average catch.

4.2 Direct and Indirect Effects of Alternative 1 – No Action/Status Quo Alternative

Fish Species	Average Annual Catch (kg) in EFHCA-related Stations¹ (2003-2013)	EFH-related Station Catch as Percent of Total Annual Research Catch (2003-2013)
Dover sole	4098.3	14.9%
Chilipepper	1937.3	29.0%
Longspine thornyhead	1840.0	16.2%
Pacific grenadier	1455.4	44.9%
Sharpchin rockfish	1373.5	42.6%
Sablefish	1212.8	14.2%
Arrowtooth flounder	981.8	15.8%
Shortspine thornyhead	892.9	22.5%
Longnose skate	871.3	13.9%
Splitnose rockfish	655.1	12.5%
Pacific hake	635.8	5.6%
Pacific sanddab	635.0	8.5%
Canary rockfish	626.3	37.8%
Giant grenadier	602.0	31.6%
Rex sole	579.6	9.8%
Spotted ratfish	526.4	16.7%
Lingcod	511.0	17.7%
Yellowtail rockfish	423.7	14.7%
Petrable sole	420.9	16.2%
Pacific spiny dogfish	409.1	4.5%
Redstripe rockfish	379.2	20.3%
Greenstriped rockfish	372.1	19.9%
California slickhead	352.2	32.1%
English sole	332.5	12.4%
Stripetail rockfish	328.0	13.3%
Shortbelly rockfish	286.5	12.1%
Halfbanded rockfish	183.0	12.6%
Bocaccio	175.7	43.6%
Pygmy rockfish	149.1	55.8%
Deepsea sole	149.0	21.8%
Darkblotched rockfish	144.2	9.6%
White croaker	130.2	32.2%
Pacific halibut	126.2	14.9%
Pacific flatnose	122.7	43.3%

4.2 Direct and Indirect Effects of Alternative 1 – No Action/Status Quo Alternative

Fish Species	Average Annual Catch (kg) in EFHCA-related Stations¹ (2003-2013)	EFH-related Station Catch as Percent of Total Annual Research Catch (2003-2013)
Rosethorn rockfish	120.5	28.8%
Widow rockfish	117.0	29.2%
Slender sole	111.4	10.9%
Sandpaper skate	109.7	14.5%
Roughtail skate	101.6	26.7%

¹EFHCA-related station refers to all survey stations that intersect a closed area either completely or partially.

Table 4.2-3 Average Annual Invertebrate Catch within Essential Fish Habitat Closed Areas by NWFSC Groundfish Bottom Trawl Surveys, 2003-2013.

Catch from within EFHCA-related stations is shown as average annual catch (kg) and as percent of total annual catch, by species, from all GBTS stations, inside and outside of EFHCA. Only species with an average annual catch totaling > 100 kg are shown. Species are listed in decreasing order of average catch.

Invertebrate Species	Average Annual Catch (kg) in EFHCA-related Stations¹ (2003-2013)	EFH-related Station Catch as a Percent of Total Annual Research Catch (2003-2013)
Fragile red sea urchin	1217.0	21.1%
Grooved tanner crab	510.0	17.0%
Brisaster urchin	448.4	14.9%
Crushed urchin	427.1	12.5%
Dungeness crab	400.7	8.8%
Mud urchin	374.8	10.5%
Jellyfish unident.	283.3	35.3%
Rough anemone	219.4	21.2%
Sponge unident.	207.7	19.6%
Echinozoa, unident.	201.9	20.4%
Brisaster spp/Brissopsis pacifica unident.	182.4	30.7%
Giant anemone	179.9	11.7%
California market squid	174.6	18.8%
Deep-sea sunflower star	167.6	41.9%
Sea pigs	145.0	18.9%
Carpet star	130.8	36.1%
Hexactinosida sponge	115.0	13.9%
Red star	112.2	7.5%
Oval sea biscuit	108.6	13.3%
Giant soft cucumber	106.3	20.5%

1. EFHCA-related station refers to all survey stations that intersect a closed area either completely or partially

As discussed in Section 4.2.1, bottom contact fishing gear can increase turbidity and alter the geochemistry in the water column around the trawl. However, these effects are temporary and localized. Given the relatively small number of survey stations in EFHCA, the short duration and small swept area of bottom trawls, the small removals of fish and invertebrates, and the avoidance of untrawlable, high-relief areas, the impacts of NWFSC research on EFHCA are considered small in magnitude, temporary or short-term in duration, and widely dispersed over a large area. The overall effect of NWFSC research on EFHCA is therefore considered minor adverse under the Status Quo Alternative according to the impact criteria in Table 4.1-1. In addition, the inclusion of GBTS data from within EFHCA has beneficial effects on region-wide fisheries stock assessments and fisheries management decisions and may be useful for exploring the impacts of EFHCA on the recovery and distribution of certain species and habitats.

4.2.2.2 Marine Protected Areas

Over 300 MPAs encompass a large fraction of the area where NWFSC research surveys are conducted (see Section 3.1.2.4). They include: State Marine Reserves (SMR), State Marine Parks (SMP), State Marine Conservation Areas (SMCA), and State Marine Recreational Management Areas (SMRMAs); National Wildlife Refuges; National Park Service MPAs; National Marine Sanctuaries; and Marine World Heritage Sites and Marine Management Areas established outside of the U.S. EEZ by international agencies and foreign governments. MPAs vary widely in the level and type of legal protection afforded to the sites' natural and cultural resources and ecological processes. Considering the wide range of conservation goals and varying degrees of legal protection associated with individual MPAs in the NWFSC research areas, it is impractical to assess the impacts of NWFSC research activities to those areas on a case-by-case basis. Locations of randomized sampling sites vary from year to year, and impacts of research surveys within particular MPAs would vary substantially over space and time. In general, the impacts to each of the MPAs are a subset of the impacts to specific physical, biological, and socioeconomic resources that are addressed in the resource specific sections of this DPEA. For all of these resources, overall impacts from NWFSC research was considered minor adverse under the Status Quo Alternative.

In addition to potentially minor adverse impacts on MPAs through capture of marine organisms and disturbance of benthic habitats, NWFSC research activities have beneficial contributions to MPAs by providing ecological information related to the science-based management, conservation, and protection of living marine resources within these areas. The information developed from NWFSC research activities is used to develop a broad array of fisheries, habitat, and ecosystem management actions taken by NMFS, as well as other federal, tribal and state authorities.

Planning for MPA locations needs to take into consideration that treaty tribes may not leave their U&A to fish elsewhere. It is critical in planning boundaries, therefore, to not only consider the biological issues but also the economic constrictions that may impact such tribal entities disparately, compared to non-tribal fishers.

4.2.2.3 National Marine Sanctuaries

National Marine Sanctuaries (Sanctuaries) are MPAs with special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archeological, educational, or aesthetic qualities. The NWFSC CCRA includes five West Coast National Marine Sanctuaries: Channel Islands, Cordell Bank, Gulf of the Farallones, Monterey Bay, and Olympic Coast (See Section 3.2). Section 304(d) of the National Marine Sanctuaries Act (NMSA) requires interagency consultation between the NOAA Office of National Marine Sanctuaries and federal agencies taking actions that are "likely to destroy, cause the loss of, or injure a sanctuary resource." If an action has the potential to adversely impact a treaty tribe, that party must also be timely brought into the consultation, pursuant to E.O. 13175 and the treaties themselves. Sanctuary consultation requires the federal action agency to

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submit a “sanctuary resource statement,” which describes the agency action and its potential effects on sanctuary resources (and as appropriate, a treaty tribe). Sanctuary resource statements are not necessarily separate documents prepared by the federal agency, and may consist of documents prepared in compliance with other statutes such as NEPA. The following analysis describes the potential effects of NWFSC research activities on each of the five West Coast Sanctuaries, and provides the requisite information for a sanctuary resource statement pursuant to section 304(d) of the NMSA.

Several NWFSC fisheries research surveys occur partially within the boundaries of the West Coast Sanctuaries. These surveys use a combination of bottom trawl gear, near-surface and mid-water trawl gear, hook-and-line gear, and various plankton nets, water sampling devices, and acoustic survey equipment to collect information about species and their habitats. Table 4.2-4 summarizes the research effort (number and percentage of trawls and sets) that occurs within each of the Sanctuaries. See Table 2.2-1 for information on the gear types and seasonality of each survey.

**Table 4.2-4 Number and Percentage of NWFSC Survey Stations Conducted
within West Coast Sanctuaries, 2008-2012**

Table indicates the number and percentage of survey stations (tows or sets) that have occurred within each of the National Marine Sanctuaries in the five-year period from 2008 through 2012. Only surveys with stations located within an NMS are shown. Several surveys use stratified random designs so the number of stations in a given area fluctuates annually.

Survey Name	Total # Stations in Survey	Olympic Coast		Cordell Bank		Gulf of the Farallones		Monterey Bay		Channel Islands	
		# within NMS	% of total	# within NMS	% of total	# within NMS	% of total	# within NMS	% of total	# within NMS	% of total
Groundfish Bottom Trawl Survey	3802	216	5.7%	35	0.9%	62	1.6%	302	7.9%	115	3.0%
Hake Acoustic Survey (mid-water trawl) ¹	218	20	9.2%	3	1.4%	3	1.4%	20	9.2%	0	
Juvenile Salmon PNW Coastal Survey (surface trawl)	694	229	33.0%	0		0		0		0	
Southern California Groundfish Hook and Line Survey (75 hooks/set)	605	0		0		0		0		130	21.5%

1. Hake survey was only conducted in 2009, 2011, and 2012.

The types of effects on Sanctuaries resulting from NWFSC research are substantially the same as those discussed for physical, biological, and socioeconomic resources elsewhere in this DPEA. These effects primarily involve impacts on benthic habitat, the removal of fish and invertebrates through sampling with various gear types, interactions with protected species, and the risk of accidental spills or contamination from vessel operation.

The only NWFSC survey that uses bottom trawl gear within the Sanctuaries is the GBTS and the impact on benthic habitat, measured as the proportion of Sanctuary area swept by trawling, is minimal. Table 4.2-5 lists the average annual footprint of bottom trawls conducted within the Sanctuaries. Other survey equipment that contacts the seafloor, such as sensors and samplers, could cause localized physical damage to benthic habitats, but the effects of such equipment on benthic habitat would be limited to very small areas because this equipment is not dragged along the seafloor.

The Southern California Groundfish Hook and Line Survey has 121 stations located within the Southern California Bight (SCB) and includes twenty-six stations within the Channel Islands National Marine Sanctuary (CINMS). This survey's primary objective is to provide an annual index of relative abundance and a time series of biological data for several key species of shelf rockfish species targeted by the recreational fishing community and not well-sampled by the GBTS due to the complex bathymetry and hard-bottom habitats of the SCB. After a period of experimentation, locations were chosen based on industry discussion and prior monitoring programs, and these precise locations (tracked using GPS) are sampled every year. Average annual catches in the CINMS from 2008-2012 are shown in Table 4.2-6 and Table 4.2-7. Additional information about the sampling effort and analysis of impacts from the Southern California Groundfish Hook and Line Survey on the CINMS is provided in Appendix E.

**Table 4.2-5 Average Annual Footprint of NWFSC Bottom Trawls Conducted
within West Coast Sanctuaries during 2008-2012**

The total area of each Sanctuary and the percentage of those areas affected by bottom trawls each year is shown. The Groundfish Bottom Trawl Survey uses a 15 meter wide trawl, nominally towed at 2.2 knots for 15 minutes, which impacts 0.01528 km² of benthic habitat with each trawl.

National Marine Sanctuary	Total Size of Sanctuary	Average Area Trawled within Sanctuary per Year	Percent of Sanctuary Trawled per Year
Olympic Coast	8,272 km ²	0.71 km ²	0.009%
Cordell Bank	1,371 km ²	0.12 km ²	0.009%
Gulf of the Farallones	3,319 km ²	0.19 km ²	0.006%
Monterey Bay	15,797 km ²	1.03 km ²	0.007%
Channel Islands	3,807 km ²	0.35 km ²	0.009%

Near-surface and mid-water trawl gear, as well as various plankton nets, water sampling devices, and acoustic survey equipment, would result in temporary disturbance and displacement of pelagic species and habitats (i.e., lasting seconds or minutes) within the Sanctuaries. The magnitude of such impacts would be minor because the effects would not result in noticeable changes to the environment.

Amounts of fish and invertebrate biomass removed from the Sanctuaries are relatively small, and the effects of biomass removal on biological populations and habitats would be minor. Table 4.2-6 shows average annual biomass removal from each West Coast Sanctuary resulting from NWFSC research from 2008 through 2012. The GBTS operates in all five Sanctuaries and is the dominant source of biomass removal (Table 4.2-6). The Juvenile Salmon PNW Coastal Survey and the Southern California Hook and Line Groundfish Survey conduct extensive sampling in the Olympic Coast Sanctuary and in the Channel Islands Sanctuary, respectively. The highest levels of biomass removal were from the two largest Sanctuaries, Olympic Coast and Monterey Bay (Table 4.2-6).

ESA-listed Fish

The Juvenile Salmon PNW Coastal Survey conducts substantial research effort within the Olympic Coast Sanctuary and catches a number of Evolutionarily Significant Units (ESU) of four salmon species, some of which are ESA-listed. As described in the analysis of impacts on fish (Section 4.2.3), the NWFSC genetically tests samples of juvenile salmon caught in various locations and has developed a partition calculator to estimate the numbers of all salmon caught that are from different ESA-listed and non-listed ESUs (See Table 4.2-11 and Table 4.2-12 in Section 4.2.3 for a breakdown of salmon catch by ESU for all surveys).

Catch data from the Juvenile Salmon Survey during 2008-2012 indicates that about 35.3 percent of all Chinook salmon caught in the survey were caught within the Olympic Coast Sanctuary, an average of 28 adults and 472 juveniles annually. Similarly, about 53.7 percent of chum salmon caught in the survey were caught within the Sanctuary, an average of 4 adults and 142 juveniles. About 33.6 percent of coho salmon caught in the survey were caught within the Sanctuary, an average of 81 adults and 246 juveniles. Finally, about 26 percent of steelhead caught in the survey were caught within the Sanctuary, an annual average of 1 adult and 45 juveniles. Compared to overall population levels for these species (Table 4.2-11 and Table 4.2-12), levels of catch are considered very small for all ESUs, (see Section 4.2.3 for analysis of impacts on salmonids from the region-wide perspective).

Other Fish

NWFSC research surveys have caught overfished species within the Sanctuaries. Non-ESA-listed DPS of Canary rockfish (average 921 kg/year) and bocaccio (339 kg/year) are two overfished species for which the majority of catch occurred within a single Sanctuary. Most of the canary rockfish was captured in the Monterey Bay Sanctuary during the GBTS and most of the bocaccio was captured in the Channel Islands Sanctuary during the Southern California Hook and Line Groundfish Survey. These levels of catch are considered very small relative to the stock size for both species (see Section 4.2.3 for analysis of impacts on fish species from the region-wide perspective). There are no data available on the status of various fish stocks within any of the Sanctuaries with which to make comparisons with research catch. Given the current NWFSC research objectives and protocols, it is currently not possible to use data from the various NWFSC surveys to provide indices of fish densities inside and outside of Sanctuary borders that may be useful for monitoring the status of different species. Such work may be possible but it would require different research designs and protocols than are currently funded.

**Table 4.2-6 Average Annual Catch of Fish within National Marine Sanctuaries
from NWFSC Surveys during 2008-2012.**

Average annual catch during the 2008-2012 period for all NWFSC surveys that fished within each NMS: Groundfish Bottom Trawl Survey (all Sanctuaries), Hake Acoustic Survey (Olympic Coast, Gulf of the Farallones, and Monterey Bay Sanctuaries), Juvenile Salmon PNW Coastal Survey (Olympic Coast Sanctuary only), and Southern California Groundfish Hook and Line Survey (Channel Islands Sanctuary only). All species with average annual catch totaling > 100 kg shown.

Fish Species	Olympic Coast (kgs)	Cordell Bank (kgs)	Gulf of the Farallones (kgs)	Monterey Bay (kgs)	Channel Islands (kgs)	Total (kgs)
Spiny dogfish	7200	43	49	204	13	7509
Dover sole	2251	96	18	3018	190	5574
Pacific hake	1333	35	177	1754	64	3364
Pacific sanddab	282	118	255	1991	681	3326

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Fish Species	Olympic Coast (kgs)	Cordell Bank (kgs)	Gulf of the Farallones (kgs)	Monterey Bay (kgs)	Channel Islands (kgs)	Total (kgs)
Arrowtooth flounder	2604	0	0	0	0	2604
Chilipepper	0	477	1	1474	50	2002
Longnose skate	888	79	54	634	122	1777
Spotted ratfish	1174	26	23	160	316	1698
Yellowtail rockfish	1548	41	0	0	52	1641
Lingcod	1334	18	27	49	161	1589
Whitebait smelt	1341	0	0	0	0	1341
Splitnose rockfish	0	45	0	1086	177	1308
Longspine thornyhead	0	0	0	1057	23	1080
Sablefish	232	36	30	729	0	1028
Pacific herring	993	0	0	0	0	993
Canary rockfish	890	22	0		5	921
Rex sole	429	30	31	361	30	880
Petrable sole	324	104	108	248	24	807
Pacific cod	806	0	0	0	0	806
Vermilion rockfish	0	0	0	0	717	717
Shortbelly rockfish	7	31	0	323	325	687
Halfbanded rockfish	0	0	0	148	477	625
Stripetail rockfish	0	85	59	417	40	602
Shortspine thornyhead	161	14	0	347	49	571
English sole	266	46	0	147	93	551
Greenstriped rockfish	397	29	46	64	1	536
Copper rockfish	0	0	0	0	474	474
Pacific grenadier	0	0	0	397	0	397
Pacific halibut	355	0	0	0	0	355
Bocaccio	0	25	0	0	314	339
White croaker	0	27	114	95	0	236
Slender sole	150	10	0	0	17	177
Sandpaper skate	114	0	0	59	0	172
Greenspotted rockfish	0	56	0	55	57	168
Pacific sardine	160	0	0	0	0	160
California slickhead	0	0	0	155	0	155
Pacific ocean perch	138	0	0	0	0	138
California skate	0	0	52	63	0	115

Marine Mammals

Two species of marine mammals have been taken in the past in the Olympic Coast Sanctuary, all in surface trawls conducted during the Juvenile Salmon PNW Coastal Survey. These historical takes are considered along with takes of marine mammals in other locations in the analysis of effects on marine mammals (Section 4.2.4). Table 4.2-7 provides information on the takes that occurred in the Sanctuary. A total of four Steller sea lions from the threatened Eastern DPS were captured in Nordic 264 surface trawls over a three day period in 2002 (the Eastern DPS was de-listed in 2013, see Section 3.2.2). A total of seven Pacific white-sided dolphins have been captured since 2003, six of which were caught in one trawl net in June of 2014.

Incidental capture of marine mammals in NWFSC research trawls has been a concern for a number of years, not just in the Olympic Coast Sanctuary but throughout the CCRA, and various mitigation measures have been implemented to reduce potential interactions. The mitigation measures implemented by the NWFSC under the Status Quo Alternative, as of the end of 2013, are described in Section 2.2.2. The capture of the six Pacific white-sided dolphins in 2014 precipitated emergency rules for the Juvenile Salmon Survey with immediate incorporation of a marine mammal excluder device for all trawls conducted with the Nordic 264. The NWFSC had been experimenting with the excluder device for several years but it was not implemented on the survey previously because it had strong selectivity issues for target fish species. The NWFSC continues to modify and test different configurations of the excluder to address the survey data issues but the excluder device was used on all trawls subsequent to capture of the six dolphins and it is part of the Preferred Alternative (Section 2.3.2).

Many marine mammals can travel long distances, entering and leaving the boundaries of the Sanctuaries in short time periods, so the potential effects on Sanctuaries is not limited to incidental capture within the boundaries of any one Sanctuary. Likewise, the potential impacts on any marine mammal species are not limited to incidental captures within the Sanctuaries. A number of marine mammals could also be disturbed by active acoustic equipment used during NWFSC research activities, at least temporarily. The NWFSC acknowledges that incidental takes and disturbance of marine mammals that may use Sanctuary habitats have had impacts on the Sanctuaries, and may continue to do so in the future under the Status Quo Alternative. However, given the lack of marine mammal stock assessments specific to any of the Sanctuaries and movement of animals with respect to Sanctuary boundaries, the NWFSC considers the appropriate context for impact analysis to be at the population level, which is provided in Section 4.2.4 for all marine mammal species.

**Table 4.2-7 Historical Takes of Marine Mammals within Olympic Coast
National Marine Sanctuary**

All takes occurred in surface trawls during the Juvenile Salmon PNW Coastal Survey.

Species	Number Killed	Date	Latitude (° north)	Longitude (° west)
Steller sea lion	1	9/22/2002	48.14333	-124.9417
Steller sea lion	1	9/23/2002	48.15000	-124.9217
Steller sea lion	2	9/24/2002	48.27833	-124.8817
Pacific white-sided dolphin	1	6/25/2003	47.54083	-124.9370
Pacific white-sided dolphin	6	6/21/2014	47.93000	-125.1000

Invertebrates

Three NWFSC research surveys have caught invertebrate species within the Sanctuaries (Table 4.2-8). For most species, the great majority of catch was taken in bottom trawls during the GBTS, although a few species such as sea nettles and Humboldt squid were caught primarily in surface trawls during the Juvenile Salmon Survey. There are no data available on the status of various invertebrate species within any of the Sanctuaries with which to make comparisons with research catch but these levels of catch are considered very small (see Section 4.2.7 for analysis of impacts on invertebrate species from the region-wide perspective). As with fish, some of the data from various NWFSC surveys could potentially be used to provide indices of invertebrate densities inside and outside of Sanctuary borders that may be useful for monitoring the status of different species.

Table 4.2-8 Average Annual Catch of Invertebrates within National Marine Sanctuaries from NWFSC Surveys during 2008-2012

Average annual catch during the 2008-2012 period for all NWFSC surveys that fished within each Sanctuary: Groundfish Bottom Trawl Survey (all Sanctuaries), Hake Acoustic Survey (Olympic Coast, Gulf of the Farallones, and Monterey Bay Sanctuaries), and Juvenile Salmon PNW Coastal Survey (Olympic Coast Sanctuary only). All species with average annual catch totaling > 100 kg shown.

Invertebrate Species	Olympic Coast (kgs)	Cordell Bank (kgs)	Gulf of the Farallones (kgs)	Monterey Bay (kgs)	Channel Islands (kgs)	Total (kgs)
Sea nettle	2410.0		809.6	892.4		4112.0
Dungeness crab	222.9	118.2	831.7	614.6		1787.4
Humboldt squid	1204.7			2.6		1207.3
Fragile sea urchin	215.9	53.8		393.7	414.9	1078.3
Sea urchins and sand dollars	166.1			506.2	388.5	1060.8
Jellyfish (unidentified)			130.9	763.2		894.1
California market squid	16.0	18.8		157.0	290.0	481.8
Giant anemone		17.2	124.0	270.1	58.5	469.8
Mud urchin	256.7			150.4		407.1
Water jelly	348.6					348.6
Red star				154.5		154.5

4.2.2.4 Conclusion

Special resource areas within the NWFSC research areas include EFH and EFHCA, MPAs, and National Marine Sanctuaries. Impacts from NWFSC-affiliated fisheries research under the Status Quo Alternative include effects on the physical environment as well as biological components. The analysis of effects on these general components (Section 4.2.1 for the physical environment and Sections 4.2.3-4.2.7 for the biological components) are reflected in the analysis for the special resource areas. The magnitude of effects on benthic habitats is relatively small and such effects would be temporary or short-term in duration. The removal of fish and invertebrates during research is also relatively small in magnitude and dispersed over time and space and unlikely to affect the populations of any species. The analysis of

research impacts within the National Marine Sanctuaries is consistent with the relatively small and temporary or short-term effects described in general. The overall effects on special resource areas under the Status Quo Alternative would be minor in magnitude, dispersed over a large geographic area, and temporary or short-term in duration, and would therefore be considered minor adverse according to the impact criteria in Table 4.1-1. In contrast to these adverse effects, the scientific data generated from NWFSC research activities could contribute beneficial effects on special resource areas through their contribution to general ecological knowledge and the status of fishery resources in the surrounding regions.

4.2.3 Effects on Fish

Under the Status Quo Alternative, fisheries research programs currently conducted and funded by the NWFSC would continue as they have for the past five years.

This section describes the effects of fishery research activities on fish species in the NWFSC fisheries research areas of the CCRA, PSRA, and LCRRA. The potential effects of research vessels, survey gear, and other associated equipment on fish species found in the research areas include:

- Mortality from fisheries research activities
- Disturbance and changes in behavior due to sound sources
- Contamination from discharges
- Modification of critical habitat for ESA-listed species

Mortality from Fisheries Research Activities

Direct mortality of fish occurs as a result of fisheries research surveys and tagging activities. Fish are taken in a variety of gear types, some of which involve experimental tests of gears designed to reduce incidental catch of non-target species or protected species. These surveys provide important data to determine biomass estimates, reproductive potential, and distribution of fish stocks, which are necessary for fisheries managers to maintain healthy populations and rebuild overfished/depressed stocks. These surveys also sample closed areas for which the areas have received protection in the form of fishery restrictions (see Section 4.2.2). The NWFSC also conducts surveys to provide indices of juvenile abundance that are used to identify and characterize the strength of year classes before fish are large enough to be harvested by commercial or recreational fisheries. Stock assessments based on accurate abundance and distribution data are essential to developing effective management strategies.

The majority of fish and invertebrates affected by the NWFSC research surveys are caught and killed during the following research activities:

- Groundfish Bottom Trawl Survey
- Bycatch Reduction Survey
- Hake Acoustic Survey
- Juvenile Salmon PNW Coastal Survey
- Northern Juvenile Rockfish Survey
- PNW Piscine Predator & Forage Fish Survey
- Near Coastal Purse Seining
- Puget Sound Marine Pelagic Food Web

The Groundfish Bottom Trawl Survey is conducted throughout the CCRA and covers the largest area of any survey conducted by the NWFSC. The PSRA and LCRRA surveys are mostly focused on juvenile salmonids and conducted on a much smaller scale than those in the CCRA.

Most of the NWFSC projects using longline, tangle net, beach seine, trap net, and hook-and-line gear are intended to catch fish for morphological measurements and tagging. Since most of these fish are released alive, mortality rates are low. The capture rate of fish species in research surveys varies substantially within each of the three research areas, with higher numbers in samples from some areas and very low or no individuals collected in other samples. In stock assessment surveys, this variability in catch is used to determine species abundance and distribution. Concentrations of biomass and species richness depend on topographic features, water temperature and salinity, prey availability, and other habitat characteristics.

Many surveys have a variety of research objectives. Some have no catch of fish (e.g., video camera projects) while others catch substantial amounts of fish in an effort to compare the efficiency of different gear types or new bycatch reduction methods. The combined catch from NWFSC-conducted surveys and those funded by the NWFSC but conducted by cooperative research partners provides the estimated catch from all NWFSC-affiliated fisheries research activities.

The impact of mortality from fisheries research depends on the magnitude of the research catch relative to the overall biomass or population level of the species. Measuring these relative effects is difficult because biomass of all species fluctuates continually and there are many species for which total biomass estimates are not known or have large confidence intervals. There are also many studies that do not collect biomass data but measure fish catch as individual counts or juvenile life stages – this is the case for all surveys in the PSRA and the LCRRA. Similarly, some surveys in the CCRA record only numbers of ESA-listed species without weights. There are no stock assessment metrics based on the numbers of individuals in the population with which to compare these research catches. For the purpose of assessing the magnitude of mortality effects in the three research areas, this DPEA compares the biomass of fish caught during NWFSC research in the CCRA to the average weight of commercial harvest in the CCRA, which is well known, and, for some species, a fisheries management metric used to prevent overfishing, the Overfishing Limit (OFL). OFLs are set at much smaller levels than overall stock biomass so the magnitude of research catches relative to them would be much less than what is indicated in the comparisons with commercial landings. In the PSRA and LCRRA, average numbers of juvenile fish of different species are reported but comparisons with commercial stock assessment metrics are not meaningful. The DPEA does not attempt to analyze the effects of research mortality on each of the hundreds of species caught in the various surveys. Rather, to demonstrate the effects of research mortality on fish stocks, it analyzes only the effects on species that are caught most frequently in the surveys in each research area (total catch over one metric ton (mt)), as well as ESA-listed species and depleted species that are rebuilding or where overfishing is occurring.

More research activities are conducted during the spring, summer, and fall when target fish species are more likely to be encountered in higher numbers (Appendix B). In comparison to commercial fisheries-related mortality, mortality due to research activities occurs in small areas, research tow times are much shorter than commercial tows, and sample sites often involve randomized selection criteria so sampling is often not repeated in the same area year to year, in contrast to commercial fisheries that focus primarily on areas of fish concentrations. This is true for all NWFSC surveys except for the Bycatch Reduction and Hake Acoustic Surveys, which do focus on areas of fish concentrations.

Disturbance and Changes in Behavior Due to Sound Sources

There are several potential mechanisms by which noise sources from research activities could disturb fish and alter behavior, including the physical movement of marine vessels and fishing gear through the water, gear contact with the substrate, and operational sounds from engines, hydraulic gear, and acoustic

devices. In addition to fishing gear noise, commercial and recreational vessels are a common part of the ambient noise in the marine environment.

Noise from active acoustic devices used on vessels conducting fisheries research could potentially affect fish. The LOA application (Appendix C, Section 6.2) describes the types of acoustic devices used on NWFSC research vessels. Fish with a swim bladder (or other air bubble) that is near, or connected to, the auditory structures likely have the best hearing sensitivity among fish, with a presumed functional hearing range of approximately 50 hertz to 4 kilohertz (Popper and Fay 2011). Herring are in this category of fish, which are specialized to hear high frequency sounds that are within the range of acoustic devices used in research. These types of fish are likely to detect acoustic devices, but only if they are relatively near the source. Because vessels are usually moving while using acoustic gear, the source of potentially disturbing sounds would be localized and the behavioral response of fish would likely be limited to temporary avoidance behavior.

Globally, approximately 25,000 fish species have a swim bladder (or other air cavity) that is not near the ear (for example, salmonids). These species probably detect some pressure from large physical disturbances of the water or vessel traffic, but functional hearing is most likely in the 30 hertz to 500 hertz range (Popper and Fay 2011) and higher frequency acoustic devices used in research are unlikely to be audible. Any acoustical effect that is audible and that would cause avoidance disturbance, would be minor in intensity, occur over a local geographic extent, and the duration would be temporary.

Commercial vessel and fishing gear noise, and recreational vessel noise are common components of background (ambient) noise in the marine environment. At present, there are thousands of commercial fishing, transport vessels, and recreational vessels in the project area that contribute to background vessel noise.

Potential disturbance and acoustic masking effects from research vessel noise under the Status Quo Alternative would likely be geographically localized, minimal in magnitude, and temporary in duration; this type of effect would be considered minor adverse for all fish species according to the impact criteria in Table 4.1-1.

Contamination from Discharges

Discharge from vessels, whether accidental or intentional, include sewage, ballast water, fuel, oil, miscellaneous chemicals, garbage, and plastics. Impacts to fish exposed to the discharge range from superficial exposure to ingestion and related effects. Even at low concentrations that are not directly lethal, some contaminants can cause sub-lethal effects on sensory systems, growth, and behavior of animals, or may be bioaccumulated (DOE 2008, NOAA 2010c).

All NOAA vessels and NWFSC chartered vessels are subject to the regulations of MARPOL 73/78, the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 (NOAA 2010b). MARPOL includes six annexes that cover discharge of oil, noxious liquid substances, harmful packaged substances, sewage, garbage, and air pollution (IMO 2010). Adherence to these regulations minimizes or negates the likelihood of discharges of potentially harmful substances into the marine environment. Annex V specifically prohibits plastic disposal anywhere at sea and severely restricts discharge of other garbage (IMO 2010). In addition, all NOAA vessels are fully equipped to respond to emergencies, including fuel spills, and crew receive extensive safety and emergency response training. These precautionary measures help reduce the likelihood of fuel spills occurring and increase the chance that they will be responded to and contained quickly.

Discharge of contaminants from NWFSC vessels and NWFSC chartered vessels is possible, but unlikely to occur in the near future. If an accidental discharge does occur, it is likely to be a rare event and the potential volume of material is likely to be small and localized. The potential impacts to fish would be

similarly short-term, localized, and likely affect a small number of animals. The overall impact of accidental contamination of fish would therefore be considered minor adverse.

As the potential effects of discharges, regulations governing discharges, and the likelihood of discharges are universal throughout the NWFSC research area, this type of potential effect on fish will not be discussed further in this analysis.

4.2.3.1 ESA-listed Species

ESA-listed fish species that occur in the NWFSC fisheries research areas include bocaccio, bull trout, (managed by USFWS), canary rockfish, green sturgeon, Pacific eulachon, steelhead, yelloweye rockfish, and all five species of ESA-listed salmon. Listing status for each distinct population segment (DPS) and occurrence of each species in the different NWFSC research areas are listed in Table 4.2-9. NMFS uses the “evolutionarily significant unit” (ESU) concept to list Pacific salmon, which are essentially equivalent to DPSs for the purpose of the ESA (79 FR 20802, April 14, 2014). Salmon species listed under the ESA will be referred to by the ESU nomenclature for the purposes of this DPEA.

Table 4.2-9 Occurrence of ESA-listed Fish Species by DPS within NWFSC Fisheries Research Areas

ESA-listed Species: Distinct Population Segment (DPS)	Status	California Current Research Area	Puget Sound Research Area	Lower Columbia River Research Area
Bocaccio: Puget Sound / Georgia Basin DPS	Endangered		X	
Canary rockfish: Puget Sound / Georgia Basin DPS	Threatened		X	
Green sturgeon: Southern DPS	Threatened	X	X	X
Pacific eulachon: Southern DPS	Threatened	X	X	X
Yelloweye rockfish: Puget Sound / Georgia Basin DPS	Threatened	X	X	
SALMONIDS				
Bull Trout DPS				
Bull trout: Columbia River DPS	Threatened	X	X	X
Bull trout: Puget Sound/Coastal DPS	Threatened	X	X	
Chinook Salmon Evolutionarily Significant Units (ESU)				
California Coastal	Threatened	X		
Central Valley Spring- run	Threatened	X		
Lower Columbia River	Threatened	X		X
Puget Sound	Threatened	X	X	
Sacramento River Winter-run	Endangered	X		
Snake River Fall-run	Threatened	X		X
Snake River Spring/Summer-run	Threatened	X		X
Upper Columbia River Spring-run	Endangered	X		X

CHAPTER 4 ENVIRONMENTAL EFFECTS

4.2 Direct and Indirect Effects of Alternative 1 – No Action/Status Quo Alternative

ESA-listed Species: Distinct Population Segment (DPS)	Status	California Current Research Area	Puget Sound Research Area	Lower Columbia River Research Area
Upper Willamette River	Threatened	X		X
Chum salmon ESU				
Columbia River	Threatened	X		X
Hood Canal Summer- run	Threatened	X	X	
Coho salmon ESU				
Central California Coast	Endangered	X		
Lower Columbia River	Threatened	X		X
Oregon Coast	Threatened	X		
Southern Oregon/Northern California Coast	Threatened	X		
Sockeye salmon ESU				
Ozette Lake	Threatened	X	X	
Snake River	Endangered	X		X
Steelhead DPS				
Central Valley	Threatened	X		
Central California Coast	Threatened	X		
Lower Columbia River	Threatened	X		X
Middle Columbia River	Threatened	X		X
Northern California	Threatened	X		
Puget Sound	Threatened	X	X	
Snake River	Threatened	X		X
South Central California Coast	Threatened	X		
Southern California Coast	Endangered	X		
Upper Columbia River	Threatened	X		X
Upper Willamette River	Threatened	X		X

Mortality from Fisheries Research Activities

Listed species have been caught incidentally in a number of NWFSC research activities. In addition, the NWFSC conducts directed research on ESA-listed salmon species both in marine waters, which are covered in this DPEA, and in fresh waters, which are not covered in this DPEA. In the CCRA, listed species have been caught in the Groundfish Survey (bottom trawl), Hake Acoustic Survey (mid-water trawl), Bycatch Reduction research (bottom trawl), Juvenile Salmon PNW Coastal Survey (surface trawl), PNW Piscine Predator & Forage Fish Survey (surface trawl), and the Near Coastal Purse Seining Survey (purse seine). In the PSRA, listed species have been captured in the Movement Studies of Puget Sound Species Survey (hook-and-line), Skagit Bay Juvenile Salmonid Survey (surface trawl), Puget Sound Marine Pelagic Food Web (surface trawl), Elwha Dam Removal Project (beach seine), Puget Sound Salmon Contaminant Study (beach seine), and Snohomish Juvenile Salmon Survey (beach seine). In the

LCRRA, listed salmon ESUs have been captured in the Columbia River Estuary Tidal Habitats Project (beach seine and trap nets), Lower Columbia River Estuary Purse Seining (purse seine), Migratory Behavior of Adult Salmon (tangle net), and Lower Columbia River Ecosystem Monitoring (beach seine).

Non-salmonids

Table 4.2-10 lists the average catch of ESA-listed non-salmonids in the three NWFSC research areas; note that most catches in the CCRA were recorded as weights while catches in the PSRA and LCRRA were recorded as individual fish, primarily juveniles. One ESA-listed non-salmonid species has been caught in the CCRA during NWFSC research in the recent past (2008-2012 survey data). Pacific eulachon are caught occasionally in trawls (Bycatch Reduction Research, Groundfish Bottom Trawl Survey/Hake Acoustic Survey), averaging 147 kg per year. At about 9.9 fish per lb (as noted for Fraser river fish in NMFS2013d), this translates to about 2900 fish, which is small in comparison to minimum spawning stock biomass estimates for the Columbia River basin of 23,000,000 spawners for 2011-2012 (also noted in NMFS 2013d). The projected level of effort in these surveys is expected to be the same under the Status Quo Alternative as it was in the past so rare or infrequent takes of eulachon would likely occur in the future. However, recent results from the Bycatch Reduction Research survey have found that some experimental technologies explored during the survey may have a significant impact on eulachon bycatch rates in the commercial pink shrimp fishery (ODFW 2014). If these technologies are shown to be effective and are ultimately employed regularly on the Bycatch Reduction Research survey, eulachon bycatch in this survey would likely be reduced from historic levels. It is also possible that other ESA-listed species in the CCRA could be caught in the future but given the lack of historical takes, future takes for other species would likely be a rare occurrence.

In the PSRA, one ESA-listed non-salmonid species has been caught in the 2008-2012 period. In 2012, 22 canary rockfish from the Puget Sound/Georgia Basin DPS were caught in hook-and-line gear during the Movement Studies of Puget Sound Species survey. While this research activity targets rockfish in part, it strives for live capture, tagging, and release to study movement patterns with telemetry gear. All canary rockfish caught in this survey were released alive, although survival was not assured. Assuming 100% mortality, this would equal approximately 94kg of dead discard (based on a 4kg maximum size for the species). While a complete abundance estimate is not available for the canary rockfish Puget Sound/Georgia Basin DPS, NMFS estimated a maximum population for the DPS of 11,000 fish in proposing the species for ESA listing (74FR 8516). And, according to the most recent canary rockfish status update (Wallace and Cope 2011), the overall West Coast spawning biomass approached 6,458mt in 2011. In relation to these metrics, even theoretically complete mortality of 22 canary rockfish on an irregular basis likely has a small impact on the population under the status quo. No ESA-listed non-salmonid species were caught during NWFSC research in the LCRRA.

The expected take levels for ESA-listed non-salmonid species in the three NWFSC research areas would likely be of very low magnitude relative to the populations of these species, distributed over relatively large areas, and would occur rarely or infrequently. Additionally, the research itself has the potential to significantly increase the amount of information available for these species. The effects of the Status Quo Alternative on ESA-listed non-salmonids are therefore expected to be minor adverse according to the impact criteria described in Table 4.1-1.

Table 4.2-10 Total Average Annual Catch of ESA-listed Non-salmonid Species by DPS within NWFSC Fisheries Research Areas, 2008-2012

ESA-listed Species: Distinct Population Segment (DPS)	Status	Average annual catch in CCRA	Average annual catch in PSRA	Average annual catch in LCRRA
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ESA-listed Species: Distinct Population Segment (DPS)	Status	Average annual catch in CCRA	Average annual catch in PSRA	Average annual catch in LCRRA
Bocaccio: Puget Sound / Georgia Basin DPS	Endangered	0	0	0
Canary rockfish: Puget Sound / Georgia	Threatened	0	22 fish	0
Green sturgeon: Southern DPS	Threatened	0	0	0
Pacific eulachon: Southern DPS	Threatened	147 kg	0	0
Yelloweye rockfish: Puget Sound / Georgia Basin DPS	Threatened	0	0	0

Salmonids

There are three challenges in providing an impact analysis for ESA-listed salmonids: determining the ESU/DPS of salmonids caught, comparing the impacts of taking primarily juvenile fish with traditional population measures, and determining the impact of taking hatchery fish versus naturally spawned fish. There are 17 ESA-listed ESUs of Pacific salmon, 11 ESA-listed DPS of steelhead, and 2 ESA-listed DPS of bull trout on the West Coast. Sixteen of the listed Pacific salmon ESUs and seven of the listed DPS of steelhead include fish from hatcheries in their ESU definitions. Twenty-four additional runs of Pacific salmon and steelhead are not ESA-listed. Determining the origin of ESUs in marine waters generally requires genetic testing unless the survey occurs in areas and times where only one ESU is present. Further complicating the analysis is that while most hatcheries clip smolt adipose fins for identification purposes, it is not a universal practice. Even though some surveys record numbers of fish with and without clipped fins, counts of those with intact fins do not necessarily mean they are from wild stock. Many NWFSC surveys record only numbers of fish caught rather than weights of fish caught. For these projects, the analysis of impacts cannot be combined directly with surveys that record weight of catch or compared with population metrics developed for fisheries management (e.g., OFL) or commercial harvest data, which are also based on biomass.

In the PSRA, the Skagit Bay Juvenile Salmonid Survey captured 157 bull trout from the Puget Sound/Coastal DPS in 2008 using a surface trawl. Only one other bull trout was captured during this survey in other years. Adult and sub-adult bull trout have also been caught on an infrequent basis in beach seines during the Snohomish Juvenile Salmon Survey. The combined catch from these surveys yields an average of 40 bull trout per year from the Puget Sound/Coastal DPS but there is large variability in catch between years. No other research projects have reported any interactions with bull trout using beach seines, surface trawls or any other gear. However, beach seines are used for several other research projects, including the Elwha Dam Removal and Puget Sound Juvenile Salmonid Survey, which could catch bull trout in the future. The beach seine surveys usually have low mortality and release incidentally caught species quickly.

Several large surveys record only numbers of juvenile and adult fish caught rather than weights of fish caught, including the Juvenile Salmon PNW Coastal Survey, Northern Juvenile Rockfish Survey, PNW Piscine Predator and Forage Fish Survey, and the Near Coastal Purse Seine Survey. All juvenile salmon captured in the Juvenile Salmon PNW Coastal Survey and Near Coastal Purse Seine Survey are sacrificed for genetic analysis to determine Pacific salmon stock of origin. Most of the research projects in the PSRA and LCRRA also only record numbers of fish caught and most of these are small juveniles. There are six surveys in the PSRA that catch ESA-listed salmon and they record numbers from each ESA-listed ESU. In the LCRRA, four surveys catch ESA-listed salmon and conduct genetic testing on samples of these fish to distinguish fish from different ESA-listed and non-ESA-listed ESUs. Genetic tests are not always able to determine the identity of salmon; fish are only assigned a specific stock of origin (i.e.,

ESU) when genetic test confidence levels are equal to or greater than an approximate threshold of 90 percent.

Data from these genetic tests has been used to develop a model that allows researchers to estimate the proportion of different ESUs for all species except sockeye in marine waters during particular seasons. This model, called a salmonid partitioning calculator, was developed by NMFS for ESA Section 10 permitting applications (for directed research on ESA-listed species) (Fresh pers. com 2014). For the purposes of this DPEA analysis, this model has been applied to counts of salmon catches in various NWFSC fisheries research projects to estimate impacts of research on various ESUs. Table 4.2-11 lists the estimated average annual takes of adult ESA-listed salmonids in the combined research areas. Table 4.2-12 lists the estimated average annual takes of juvenile ESA-listed salmonids in the combined research areas. Research fish categorized as adult or subadult were included in Table 4.2-11; fish categorized as smolt or juvenile were included in Table 4.2-12.

The distribution of catch among ESUs reflects the overlap of fish abundance with survey efforts. For a few areas and stocks, ESA-listed stocks account for a substantial part of the total research catch. These cases are typically the result of targeted research effort in particular areas where fish from certain ESUs or DPSs are likely to be found. O, although overall numbers of juvenile fish caught are still relatively small and many are released alive.

A small and highly variable percentage of juvenile salmon survive to maturity and safely return to natal streams to spawn. Comparisons of juvenile salmon caught in research to commercial harvests of adult salmon are therefore not useful measurements of impact. However, the relationship between juveniles caught and estimates of juvenile abundance, and between caught adult fish and spawning population estimates can be informative. Survivability of juvenile salmon decreases with each life stage so for juvenile salmon and steelhead, the number produced is much larger than the number that make it to areas where juvenile salmon and steelhead may be intercepted by survey gear covered in this DPEA. Similarly, the number of adult salmon that are captured by survey gear in marine and estuarine waters are from populations that are larger than the number of fish that actually make it to spawn or be collected for hatchery production. So while population sizes of Pacific salmon and steelhead ESA-listed populations at the time of survey interception, comparison to spawning and juvenile release populations can provide insight.

As shown in Table 4.2-12, the number of smolts and other types of juvenile salmon spawned in the wild as well as those augmented by hatchery production can be quite large. The total annual output of juvenile salmon and steelhead from the various ESA-listed ESUs and DPSs is approximately 175 million. In comparison, the total number of juvenile salmon taken during research surveys between 2008 and 2014 was 63,687, of which there were 12,294 mortalities for an annual average of 1,756 fish killed. Examined at the ESUs or DPS level, those percentages remain relatively small, even for populations which produce smaller numbers of smolts annually. The amount of juvenile salmon and steelhead caught in NWFSC research is a very small percentage of each ESU and DPS.

NWFSC surveys have rarely caught adult salmon in the recent past. 780 adult salmon and steelhead were taken during surveys in all research areas between 2008 and 2014. Of these, there were 89 mortalities. In comparison to overall population size estimates for ESA-listed species (approximately 1 million), catch and mortality rates are very small. Examining the number of caught fish attributed to individual ESUs and DPSs (Table 4.2-11), the average annual catch is less than 5 fish per year except from four specific ESUs – Lower Columbia River and Puget Sound chinook, and from Lower Columbia River and Oregon Coast coho. Despite the higher numbers of intercepted fish (still generally small compared to spawning population estimates) from these ESUs, mortality rates were less than 34%. The reasons for this are not clear, as not all the ESUs with higher annual catch rates are from the largest estimated population sizes (although this may be a contributing factor for the Lower Columbia and Oregon Coast coho ESUs). Also

of note is there were zero reported catches of salmon and steelhead from ESUs and DPSs for which population estimates are less reliable.

The NWFSC considers the adverse impacts of its various research activities on ESA-listed salmonids to be very small in magnitude, dispersed in time and geographic area, and likely to have minimal impact on all ESUs in all three research areas. In contrast to these minor adverse effects, NWFSC research on Pacific salmon has beneficial impacts on both ESA-listed and non-listed ESUs through its contribution to sustainable fisheries management, reducing bycatch of vulnerable ESUs, helping to monitor the recovery of ESA-listed species, and monitoring changes in the marine environment important to the recovery of these species. Overall, the impact of NWFSC research on ESA-listed salmonids under the Status Quo Alternative is considered minor adverse according to the impact criteria described in Table 4.1-1.

Table 4.2-11 Comparison of Estimated Population (Counts) of Adult ESA-listed Salmonids by ESU/DPS to Counts of Adults Taken during NWFSC Fisheries Research Activities, 2008-2014

ESA-listed Salmonids	Status	Average spawning population estimate ¹	Average adult research take all areas	% Research take compared to adult population	Average adult research mortality all areas	% Research mortality compared to adult population
CHINOOK SALMON ESU						
California Coastal	Threatened	4,921	3.0	0.06%	3.0	0.06%
Central Valley Spring- run	Threatened	5,890	0	0%	0	0%
Lower Columbia River	Threatened	36,462	21.9	0.06%	2.7	<0.01%
Puget Sound	Threatened	29,216	13.6	0.05%	4.6	0.02%
Sacramento River Winter-run	Endangered	2,106	0	0%	0	0%
Snake River Fall-run	Threatened	44,913	2.7	<0.01%	2.0	<0.01%
Snake River Spring/Summer-	Threatened	80,480	0.7	<0.01%	0.1	<0.01%
Upper Columbia River Spring-	Endangered	82,74	0.3	<0.01%	0.3	<0.01%
Upper Willamette River	Threatened	49,196	1.9	<0.01%	0.4	<0.01%
CHUM SALMON						
Columbia River	Threatened	12,667	0	0%	0	0%
Hood Canal Summer- run	Threatened	21,008	0	0%	0	0%
COHO SALMON						
Central California Coast	Endangered	1,621	0	0%	0	0%
Lower Columbia River	Threatened	219,149	51.9	0.02%	0.7	<0.01%
Oregon Coast	Threatened	194,184	18.5	<0.01%	0.2	<0.01%
Southern Oregon/Northern California Coast	Threatened	18,847	1.0	<0.01%	0	0%

CHAPTER 4 ENVIRONMENTAL EFFECTS
4.2 Direct and Indirect Effects of Alternative 1 – No Action/Status Quo Alternative

ESA-listed Salmonids	Status	Average spawning population estimate ¹	Average adult research take all areas	% Research take compared to adult population	Average adult research mortality all areas	% Research mortality compared to adult population
SOCKEYE SALMON (No Partition Calculator Available)						
Ozette Lake	Threatened	1,716	0	0%	0	0%
Snake River	Endangered	1,278	0	0%	0	0%
STEELHEAD DPS						
Central California Coast	Threatened	5,289	0	0%	0	0%
Central Valley	Threatened	4,480	0	0%	0	0%
Lower Columbia River	Threatened	34,117	0	0%	0	0%
Middle Columbia River	Threatened	26,851	0.1	<0.01%	0	0%
Northern California	Threatened	3,607	0	0%	0	0%
Puget Sound	Threatened	14,615	0	0%	0	0%
Snake River	Threatened	185,864	0.1	<0.01%	0	0%
South Central California Coast	Threatened	730	0	0%	0	0%
Southern California Coast	Endangered	60	0	0%	0	0%
Upper Columbia River	Threatened	10,664	0	0%	0	0%
Upper Willamette River	Threatened	6,030	0	0%	0	0%

1. For most ESUs, Spawning Population Estimate was derived from the most recent available Biological Opinions, online at <https://pcts.nmfs.noaa.gov/pcts-web/publicAdvancedQuery.pcts>

2. Population estimate based on information outlined in Williams et al 2011. Accordng to the document, there is a great deal of unknown about these ESUs due to irregular estimate methodology and incomplete survey methodology. Information is presented here as a very loose interpretation of possible abundance.

3. Average research catch based on those years for which takes of ESU/DPS were requested and authorized. For most, this is the years 2008-2014

Table 4.2-12 Comparison of Estimated Population (Counts) of ESA-listed Salmonids by Species and Catch (Counts) of Juvenile ESA-listed Salmonids by Species and ESU Taken during NWFSC Fisheries Research Activities, 2008-2014

ESA-listed Salmonids	Status	Average natural juveniles produced	Average hatchery juveniles produced	Average total juveniles produced	Average juvenile research take all areas	% Research take compared to juvenile population	Average juvenile research mortality all areas	% Research mortality compared to juvenile population
CHINOOK SALMON ESU								
California Coastal	Threatened	Unknown	0	unknown	0	0%	0	0%
Central Valley Spring run	Threatened	2,178,601	3,749,130	5,927,731	0	0%	0	0%
Lower Columbia River	Threatened	36,407,748	13,271,270	49,679,018	818.9	<0.01%	325.0	<0.01%
Puget Sound	Threatened	2,337,280	42,609,650	44,946,930	6988.1	0.02%	910.9	<0.01%
Sacramento River Winter-run	Endangered	193,900	161,840	355,740	0	0%	0	0%
Snake River Fall-run	Threatened	6,856,771	570,821	7,427,592	35.1	<0.01%	19.7	<0.01%
Snake River Spring/Summer-run	Threatened	5,545,380	1,454,727	7,000,107	44.0	<0.01%	30.6	<0.01%
Upper Columbia River Spring-run	Endangered	1,461,876	519,166	1,981,042	20.4	<0.01%	12.4	<0.01%
Upper Willamette River	Threatened	6,049,133	1,813,726	7,862,859	84.6	<0.01%	61.4	<0.01%
CHUM SALMON ESU								
Columbia River	Threatened	391,973	2,978,550	3,370,523	567.6	0.02%	20.1	<0.01%
Hood Canal Summer- run	Threatened	275,000	3,072,420	3,347,420	11.7	<0.01%	0	0%
COHO SALMON ESU								
Central California Coast	Endangered	225,825	90,580	316,405	0	<0.01%	0	0%
Lower Columbia River	Threatened	8,937,124	839,118	9,776,242	373.9	<0.01%	262.1	<0.01%
Oregon Coast	Threatened	60,000	13,470,170	13,530,170	88.3	<0.01%	88.3	<0.01%
Southern Oregon/Northern California Coast	Threatened	775,000	841,348	1,616,348	4.7	<0.01%	4.7	<0.01%

ESA-listed Salmonids	Status	Average natural juveniles produced	Average hatchery juveniles produced	Average total juveniles produced	Average juvenile research take all areas	% Research take compared to juvenile population	Average juvenile research mortality all areas	% Research mortality compared to juvenile population
SOCKEYE SALMON ESU								
Ozette Lake	Threatened	305,000	353,282	658,282	0	0%	0	0%
Snake River	Endangered	117,601	13,259	130,860	3.3	<0.01%	1.7	<0.01%
STEELHEAD DPS								
Central California Coast	Threatened	648,891	161,866	810,757	0	0%	0	0%
Central Valley	Threatened	1,600,653	127,514	1,728,167	0	0%	0	0%
Lower Columbia River	Threatened	1,028,157	447,659	1,475,816	7.0	<0.01%	5.6	<0.01%
Middle Columbia River	Threatened	773,669	540,850	1,314,519	6.6	<0.01%	6.0	<0.01%
Northern California	Threatened	0	410,296	410,296	0	0%	0	0%
Puget Sound	Threatened	219,897	1,668,371	1,888,268	32.0	<0.01%	0	0%
Snake River	Threatened	4,046,223	1,399,511	5,445,734	20.3	<0.01%	16.4	<0.01%
South Central California Coast	Threatened	0	83,038	83,038	0	0%	0	0%
Southern California²	Endangered	Unknown	0	Unknown	0	0%	0	0%
Upper Columbia River	Threatened	834,220	286,452	1,120,672	2.9	<0.01%	2.4	<0.01%
Upper Willamette River	Threatened	0	215,847	215,847	1.4	<0.01%	1.4	<0.01%

Modification of Critical Habitat for ESA-listed Species

Section 3.2.1.1 describes the areas designated as Critical Habitat (CH) for the eulachon Southern DPS, green sturgeon Southern DPS, Puget Sound/Georgia Basin DPSs for bocaccio, yelloweye and canary rockfish, and ESA-listed salmonids (salmon ESUs and steelhead and bull trout DPSs). The critical habitat that overlaps with the NWFSC research areas considered in the DPEA include:

- Eulachon CH in the Columbia River and select tributaries (within LCCRA)
- Green sturgeon CH in marine waters of the West Coast from Cape Flattery to Monterey Bay (within CCRA), sections of Puget Sound (within PSRA), and the Columbia River estuary (within LCCRA)
- Rockfish CH in many parts of Puget Sound (within PSRA)
- Salmonid CH in marine waters of the West Coast from Cape Flattery to San Diego Bay (within CCRA), sections of Puget Sound (within PSRA), and the Columbia River estuary (within LCCRA)

Eulachon consume phytoplankton, zooplankton, crustaceans and other small species at various stages of their lives (NMFS 2011e). Such small items are only caught with plankton nets during NWFSC surveys in the LCCRA, and only minimal amounts when they are. Additionally, eulachon are primarily in the LCCRA as juveniles and during spawning events (during which time they do not feed), further minimizing the potential effect of prey removal as a result of NWFSC surveys.

Surveys in the LCCRA utilize different types of gear. Trap nets and tangle nets are anchored to the bottom but are not dragged, minimizing effects on bottom habitat. Various seines are used but they do not have bobbins or roller gear and have minimal effect on benthic habitat.

Green sturgeon consume various shrimp, clams, juvenile crabs, and small baitfish species in the Columbia River estuary (NMFS 2009c). Benthic items are only caught with bottom nets, which are not used in NWFSC surveys in the LCCRA. Baitfish are caught in LCCRA and PSRA surveys using plankton nets and other similar small mesh mid-water gear, but only in minimal amounts. Green sturgeon spend most of their lives in marine waters of the CCRA, and much of their time appears to be spent near the bottom (NMFS 2009c). It is unknown what specifically they feed on but it is likely they eat the same types of items that they eat in estuaries. Bottom trawl surveys catch many of these prey species. However, as noted in the sections on fish and invertebrate catches (Section 4.2.3 Target Fish and Section 4.2.7 Invertebrates), the amount caught by NWFSC surveys is very small in comparison to available metrics (commercial fisheries, recreational fisheries, and biomass estimates) and unlikely to effect the availability of prey to green sturgeon in CH within any of the three research areas.

Green sturgeon have not been found to spawn in any of the NWFSC research areas so this is not considered a habitat concern. Bottom trawls and other mobile bottom-contact gear utilized in the CCRA and PSRA can disrupt the ocean floor and benthic sediment. This can disturb or damage important foraging habitats for green sturgeon, and cause turbidity in the water that could make it difficult for green sturgeon to locate prey. However, surveys conducted by NWFSC research programs impact very small areas of the ocean floor relative to the entire area and relative to the footprint of commercial fisheries (see Section 4.2.2), and, due to the stratified random design of many surveys, typically do not occur in the same geographic location from year to year. The impacts of research gear on benthic habitat, including green sturgeon CH, are therefore small in magnitude and temporary in duration.

All life stages of ESA-listed rockfish are found in the PSRA. Their food habits are generally similar and include numerous zooplankton, copepod and phytoplankton species for juveniles, and larger crustaceans, urchins, and numerous fish species for adults. (NMFS 2014g). Such species are commonly caught during NWFSC surveys in the PSRA, but only in small amounts relative to biomass estimates or catch rates in

commercial fisheries (Section 4.2.3 Target Fish and Section 4.2.7 Invertebrates) and research removals are unlikely to effect the availability of prey to ESA-listed rockfish in the Puget Sound CH.

The Movement Studies of Puget Sound Species survey uses a bottom trawl, which can disrupt the basin floor and benthic sediment. However, this survey conducts 12 short tows per year, impacting a very small area of Puget Sound, and adult ESA-listed rockfish generally prefer very rough bottom of varying steepness (NMFS 2014g) which bottom trawl surveys tend to avoid due to the potential for gear damage. Similarly, beach seines and other surveys that contact the bottom are likely not set in these types of habitats. The potential impact of NWFSC surveys on benthic habitat important to ESA-listed rockfish, including CH, is therefore small in magnitude and temporary in duration.

CH for salmonids is very complicated and is described for each ESU/DPS at: http://www.westcoast.fisheries.noaa.gov/maps_data/endangered_species_act_critical_habitat.html. All life stages of ESA-listed salmonids are found to varying degrees in one or more NWFSC research areas. Their food habits are generally similar and include numerous insects, crustaceans and small fish for juveniles (NOAA Fisheries 2005), and larger crustaceans and fish species for adults. Such species are commonly caught in NWFSC surveys, but only in small amounts relative to biomass estimates or catch rates in commercial fisheries (Section 4.2.3 Target Fish and Section 4.2.7 Invertebrates) and research removals are unlikely to effect the availability of prey to ESA-listed salmonids in any of the three NWFSC research areas.

As described above for other ESA-listed species, NWFSC fisheries includes a variety of gears that may cause disruption and increased turbidity in benthic environments. However, the level of research efforts with these gear types is very small compared to the amount of available habitat and, due to the stratified random design of many surveys, typically do not occur in the same geographic locations from year to year. Although insufficient information is available to assess potential impacts on each particular salmonid CH, the general impacts of NWFSC research on benthic habitats is very small in magnitude and temporary in duration. This conclusion likely holds for all the different salmonid CH as well.

For the same reasons described in the introduction section on contamination, potential effects on CH of ESA-listed fish from accidental discharges of fuel or other contaminants from NWFSC research vessels are possible but unlikely to occur in the near future. If an accidental discharge does occur, it is likely to be a rare event and the potential volume of material is likely to be small and localized. The potential impacts to fish CH would be similarly short-term, localized, and likely small in magnitude.

The expected impact on CH for all ESA-listed fish from NWFSC research would likely be of very low magnitude, distributed over relatively large areas, and would be temporary in duration. The effects of the Status Quo Alternative on ESA-listed fish CH is therefore expected to be minor adverse according to the impact criteria described in Table 4.1-1. Additionally, the research itself is intended to increase the amount of information available regarding the ecological components of the various CH and to monitor trends over time. Such information has beneficial effects on ESA-listed species and management of their CH.

4.2.3.2 Target and Other Species

Mortality from Fisheries Research Activities

California Current Research Area

Table 4.2-13 shows the average annual NWFSC research catch (by weight) of the most frequently caught fish species in the recent past (2008-2012). Only species with total catch greater than one metric ton (1000 kgs) and those that are overfished or rebuilding are listed. To give an indication of their relative size, these average annual research catches are compared to the commercial landings for Washington,

Oregon, and California, if known. No commercial catch data were available for a number of species that either do not have directed fisheries or may not be differentiated by species during harvest (e.g., minor rockfish species). For some commercially important stocks, average research catches are also compared to the Overfishing Limit (OFL) for 2014, a fisheries management metric used to prevent overfishing. OFLs is defined as “an estimate of the catch level above which overfishing is occurring” (50CFR600.310(e)(2)(D)). This makes them a good metric for comparing research catch to overall population strength.. Table 4.2-13 indicates that for most species the average amount of fish killed in NWFSC research is less than 10 percent of commercial landings and even smaller relative to the 2014 OFL for these fish. For these species, the magnitude of research mortality is very small under the Status Quo Alternative and is therefore considered minor adverse.

For several species, including splitnose rockfish, Pacific ocean perch, canary rockfish (non-ESA-listed DPS), and aurora rockfish, the average annual research catch exceeds 10 percent of commercial catch (Table 4.2-13). For most of these species, current commercial landings are greatly diminished from historical fishery levels for various reasons. For all of them, research catch is less than 10 percent of OFL, which provides a better measure of research mortality relative to the exploitable population for each stock. In addition, NWFSC research provides the most reliable data for tracking the abundance and distribution of these stocks and thus provides critical information for monitoring their status and recovery.

NWFSC fisheries surveys also catch some stocks of species that are considered overfished or are rebuilding, including non-ESA-listed DPS of bocaccio and canary rockfish as well as cowcod, darkblotched rockfish, Pacific ocean perch, yelloweye rockfish, and Petrale sole (Table 4.2-13). Average NWFSC research catch exceeds 10 percent of commercial catch for two of these species, Pacific ocean perch and canary rockfish, although research catch is less than one percent of OFL for both species. All of these species are subject to rebuilding plans and other fishery management actions to reduce targeted catch of these species and reduce bycatch in other fisheries to help them recover and prevent future overfishing. The Fishery Management Councils and NMFS use criteria in fishery management plans to set annual catch limits for target species to meet these conservation objectives.

The process of determining annual catch limits for commercial fisheries includes estimates of mortality from research. However, unexpectedly high research catches may be of concern for species that are being fished at rates close to the annual catch limit, resulting in total catch exceeding the catch limit and affecting the closure of commercial fisheries. This situation occurred in 2006 with canary rockfish.

Harvest of depleted species is closely monitored within the fishing season, including catch by research activities, and the commercial fishery is closed if the total catch approaches the annual catch limit. For the start of 2006 fisheries, the PFMC set aside approximately 3.0 mt of canary rockfish to accommodate scientific research activities that would occur that year, including research by the NWFSC. The remainder of the optimum yield was made available for commercial fisheries, with most going to the Pacific coast groundfish fishery. The NWFSC Groundfish Bottom Trawl Survey selects sampling sites every year based on a stratified randomized design and the 2006 selections included one sample site that happened to occur in a location with a high density of canary rockfish; almost the entire tow was canary rockfish. Researchers were aware that canary rockfish was a species of concern and that research catch would be at least twice as high as expected. They immediately contacted staff at NMFS Sustainable Fisheries Division, who subsequently alerted staff at the PFMC. At the September 2006 PFMC meeting, the best estimate of canary rockfish catch in scientific research activities was increased from 3.0 mt to 7.5 mt which, when combined with anticipated catch from various fisheries, totaled 102.5 percent of the 2006 optimum yield of 47.1 mt. This led to a compensatory in-season reduction in the commercial catch. This situation has not occurred for any species since that time, although the annual catch limit process and in-season monitoring process continue.

In general, the type of programmatic analysis presented in this section indicates that research activities have minimal impact on target species, including overfished species, and therefore pose little

conservation concern. However, this programmatic analysis is based on average catch levels over a five-year period, with all fishery management sub-regions combined, and comparisons with an area-wide harvest metric from a particular year. This approach may not accurately reflect the potential effects of research on overfished stocks in particular years or specific fishery management sub-regions. The status and trends of such stocks can change rapidly, either increasing or decreasing, and average catch per unit effort can vary dramatically from year to year with change in abundance. In addition, research catch in one fishery management region where a species is not overfished could be problematic if it was conducted in a region where the stock is overfished and the commercial fisheries have been curtailed to help the overfished stock rebuild.

Most research activities conducted by the NWFSC are multi-species surveys that cover large areas, involve minimal sampling, and do not target overfished species. Research catches in these surveys are generally very small for uncommon species. However, bycatch reduction research projects are often focused on a particular species or group of fish (e.g., rockfish) and could catch substantial amounts of targeted fish in a relatively small area, e.g. studies comparing different configurations of commercial fishing gear. Such research directed at an overfished stock could theoretically account for a substantial portion of the annual catch limit for that stock and could interfere with the rebuilding plan for that stock.

Research data is necessary for monitoring the status of overfished stocks and other stocks of conservation concern and to determine if management objectives for rebuilding those stocks are being met. Under the Status Quo Alternative, proposals for scientific research projects must go through a rigorous process to get scientific research permits or experimental fishing permits under the MSA. The potential impacts of those proposed projects are assessed for each stock, including overfished stocks, before those permits are issued. Fisheries managers typically consider the estimated amount of research catch from all projects along with other sources of mortality (e.g., bycatch in other fisheries and predation) before setting commercial fishing limits to prevent overfishing of stocks or to help overfished stocks rebuild. This type of annual review of research proposals would continue to occur in the future under the Status Quo Alternative. Any future proposed projects targeting overfished stocks, or projects likely to have substantial bycatch of an overfished stock, would receive additional scrutiny on a stock by stock basis to ensure minimal impact on the stock before a research permit is issued under the MSA. These permitting reviews would also determine whether the proposed projects were consistent with the NEPA analysis presented in this DPEA or whether additional NEPA analysis was required (see Section 2.3.4).

Table 4.2-13 indicates that, while mortality to fish species is a direct effect of the NWFSC surveys and research projects, there are likely no measurable population changes occurring as a result of these research activities because they represent such a small percentage of fish taken in commercial fisheries, which are just fractions of the total populations for these species. For all target species in the CCRA, mortality from NWFSC research activities would be low in magnitude, dispersed over a wide geographic area, and therefore considered minor adverse for all target species under the Status Quo Alternative.

Table 4.2-13 Relative Size of NWFSC Research Catch in California Current Research Area Compared to Commercial Catch and 2014 Overfishing Limit.

Only target species taken in excess of 1 metric ton (1000 kg) per year and species that are overfished are shown.

Common Name	Stock Status	Avg Annual Research Catch (2008-2012) From All Surveys Combined (mt)	Avg Annual Commercial Catch (2008-2012) from West Coast States (mt) ¹	Average Research Catch (2008-2012) as Percent of Commercial Catch	2014 West Coast OFL ² (mt)	Average Research Catch (2008-2012) as Percent of OFL
Pacific hake	Not overfished	1,181.0	63,974	1.8%	NA ³	

CHAPTER 4 ENVIRONMENTAL EFFECTS

4.2 Direct and Indirect Effects of Alternative 1 – No Action/Status Quo Alternative

Common Name	Stock Status	Avg Annual Research Catch (2008-2012) From All Surveys Combined (mt)	Avg Annual Commercial Catch (2008-2012) from West Coast States (mt) ¹	Average Research Catch (2008-2012) as Percent of Commercial Catch	2014 West Coast OFL ² (mt)	Average Research Catch (2008-2012) as Percent of OFL
Dover sole	Not overfished	42.9	9,044	0.5%	77,774	0.06%
Sablefish	Not overfished	25.7	6,309	0.4%	7,158	0.36%
Arrowtooth flounder	Not overfished	23.7	2,792	0.8%	6,912	0.34%
Lingcod	Not overfished	22.1	309	7.2%	4,438	0.50%
Spiny dogfish	Not overfished	21.2	280	7.6%	2,950	0.72%
Longspine thornyhead	Not overfished	20.5	Unknown		3,304	0.62%
Longnose skate	Not overfished	20.3	Unknown		2,816	0.72%
Yellowtail rockfish	Not overfished	15.9	848	1.9%	5,648	0.28%
Petrale sole	Rebuilding	14.4	1,358	1.1%	2,774	0.52%
Shortspine thornyhead	Not overfished	11.7	1,205	1.0%	2,310	0.51%
Pacific sanddab	Unknown	9.3	186	5.0%	4,801	0.19%
Pacific halibut	Not overfished	8.3	801	1.0%	NA ³	
Widow rockfish	Not overfished	8.1	137	5.9%	4,435	0.18%
Rex sole	Unknown	7.7	444	1.7%	4,372	0.18%
Splitnose rockfish	Not overfished	7.3	35	20.6%	974	0.75%
Pacific ocean perch	Overfished	7.1	48	14.8%	838	0.85%
Pacific Herring	Monitored	7.1	834	0.9%	NA ³	
Pacific cod	Not overfished	7.0	391	1.8%	3,200	0.22%
English sole	Not overfished	5.8	677	0.9%	5,906	0.10%
Spotted ratfish	Unknown	5.2	Unknown		1,441	0.36%
Greenstriped rockfish	Not overfished	5.1	Unknown		1,501	0.34%
Chilipepper	Not overfished	4.3	240	1.8%	1,852	0.23%
Redstripe rockfish	Unknown	3.9	Unknown		270	1.44%
Northern anchovy	Monitored	3.9	4,973	0.1%	139,000	<0.01%
Sharpchin rockfish	Unknown	3.8	Unknown		224	1.69%
Pacific grenadier	Unknown	3.5	Unknown		15,190	0.02%

CHAPTER 4 ENVIRONMENTAL EFFECTS
4.2 Direct and Indirect Effects of Alternative 1 – No Action/Status Quo Alternative

Common Name	Stock Status	Avg Annual Research Catch (2008-2012) From All Surveys Combined (mt)	Avg Annual Commercial Catch (2008-2012) from West Coast States (mt) ¹	Average Research Catch (2008-2012) as Percent of Commercial Catch	2014 West Coast OFL ² (mt)	Average Research Catch (2008-2012) as Percent of OFL
Canary rockfish	Overfished	3.2	13.6	23.5%	741	0.43%
Darkblotched rockfish	Rebuilding	3.1	125	2.5%	553	0.56%
Stripetail rockfish	Unknown	2.5	Unknown		64	3.91%
Whitebait smelt	Monitored	1.9	218	0.9%	NA ³	
Giant grenadier	Unknown	1.8	124	1.5%	NA ³	
Rougeye rockfish	Unknown	1.5	Unknown		72	2.10%
Halfbanded rockfish	Unknown	1.4	Unknown		NA ³	
Shortbelly rockfish	Not overfished	1.4	Unknown		6,950	0.02%
Big skate	Unknown	1.3	Unknown		458	0.28%
Aurora rockfish	Not overfished	1.1	1.2	99.5%	42	2.65%
Rosethorn rockfish	Unknown	1.1	Unknown		15	7.33%
Bocaccio	Rebuilding	0.85	7	12.1%	1,165	0.07%
Cowcod	Rebuilding	<0.01	3	0.1%	12	0.04%
Yelloweye rockfish	Overfished	<0.01	3	0.1%	51	0.01%

1. Source: Commercial landing data from NMFS Office of Sustainable Fisheries website: <http://www.st.nmfs.noaa.gov/commercial-fisheries/commercial-landings/annual-landings/index>

2. Source: Status of the Pacific Coast Groundfish Fishery, SAFE (PFMC 2014a), and Status of the Pacific Coast Pelagic Species Fishery, SAFE (PFMC 2014b)

3. For some species, an OFL has either not been established or are managed through use of concepts and strategies other than OFL. OFL is not available for these species.

As described above in the ESA-listed salmon section, most of the PSRA research projects target juvenile fish, many of which are released alive, and only record numbers of fish caught rather than weights. Research projects targeting adult fish, such as the Movement Studies of Puget Sound Species, are designed for live-capture and release after measuring and tagging. This makes it difficult to analyze impacts of research compared to commercial or recreational fisheries in Puget Sound, which harvest adult fish recorded by weight. The most commonly caught non-salmonids in the PSRA (average number of fish per year, 2008-2012) include the following: threespine stickleback (~275,000 fish), Pacific herring (49,378), surf smelt (27,359), shiner perch (23,034), Pacific sand lance (21,051), juvenile pink salmon (15,891), Pacific tomcod (3,945), starry flounder (3,502), English sole (1,005), and lingcod (791). However, most of these are very small size classes and if these numbers of fish were converted to weight of catch, the only species that would likely exceed one metric ton would be starry flounder, Pacific herring, lingcod, and Pacific tomcod. None of these species are overfished and this level of research catch does not pose conservation concerns or fishery management issues for any species.

Under the Status Quo Alternative, NWFSC research activities would result in the mortality of very small quantities of fish from the PSRA, most of which would be juvenile fish or forage fish species. For all target species in the PSRA, mortality from NWFSC research activities would be low in magnitude, dispersed over a wide geographic area, and therefore considered minor adverse for all target species under the Status Quo Alternative.

Lower Columbia River Research Area

The effects of NWFSC research on fish species in the LCRRA are very similar to those described for the PSRA above. The most commonly caught non-salmonids in the LCRRA (average number of fish per year, 2008-2012) include the following: northern anchovy (~285,000 fish) threespine stickleback (~206,000), surf smelt (5071), banded killish (3,345), peamouth (1,583), chiselmouth (1,559), yellow perch (1,496), Pacific herring (1,485), shiner perch (1,469), common carp (1,113), and starry flounder (371). However, most of these are very small fish and if these numbers of fish were converted to weight of catch, the only species that would likely exceed one metric ton would be northern anchovy, common carp, and starry flounder. None of these species are overfished and this level of research catch does not pose conservation concerns or fishery management issues for any species.

Under the Status Quo Alternative, NWFSC research activities would result in the mortality of very small quantities of fish from the LCRRA, most of which would be juvenile fish or forage fish species. For all target species in the LCRRA, mortality from NWFSC research activities would be low in magnitude, dispersed over a wide geographic area, and therefore considered minor adverse for all target species under the Status Quo Alternative.

4.2.3.3 Conclusion

NWFSC fisheries research conducted under the Status Quo Alternative could have effects on ESA-listed species, commercially and recreationally targeted species, and non-managed fish species through mortality, disturbance, and changes in habitat. Impacts on fish habitats would be limited to temporary and localized increases in turbidity from research bottom-contact gear and, in rare cases, accidental contamination from fuel spills and other compounds from research vessels. Given the spill response equipment and emergency training required of all research vessels by Coast Guard regulations regarding safety and pollution prevention, and the experience of NOAA Corps and charter captains and crew, the potential for accidental fuel spills or other contamination from research vessels is considered small and any incidents would likely be rare, small in magnitude, and quickly contained (Section 4.2.1).

For ESA-listed species, rare or infrequent incidental captures of non-salmonid species has occurred in the CCRA (Pacific eulachon of the Southern DPS) and PSRA (canary rockfish of the Puget Sound/George Basin DPS). Such incidental captures would likely continue to occur on an irregular basis under the Status Quo Alternative. Other ESA-listed non-salmonid species could be caught in the three NWFSC research areas but would likely be rare if they occurred. Overall mortality of these species would be of very low magnitude compared to the populations of these species, distributed over relatively large areas, and would occur rarely or infrequently. The effects of the Status Quo Alternative on ESA-listed non-salmonids are therefore expected to be minor adverse according to the impact criteria described in Table 4.1-1.

Salmonids have also been caught in the past. Bull trout of the Puget Sound/coastal DPS have irregularly been caught in the PSRA. Juvenile ESA-listed salmon and steelhead are regularly caught in NWFSC research in all three research areas, some of which is directed research on these species in response to needs for information important to the recovery of the species. NWFSC surveys infrequently catch adult salmon, averaging less than 112 fish from all ESUs per year, and many of these fish are released after tagging and measurement without apparent harm. One project in the LCRRA targets adult salmon but uses traps to capture them alive for tagging and release. Many juvenile fish captured in beach seines and tangle nets are also released alive after data recording, further reducing potential impacts. Comparisons of

juvenile salmon caught in research to commercial harvests of adult salmon or ESU stock assessments are not useful measurements of impact. The NWFSC considers the adverse impacts of its various research activities on ESA-listed salmonids to be very small in magnitude, dispersed in time and geographic area, and likely to have minimal impact on all ESUs in all three research areas. In contrast to these minor adverse effects, NWFSC research on Pacific salmon has beneficial impacts on both ESA-listed and non-listed ESUs through its contribution to sustainable fisheries management, reducing bycatch of vulnerable ESUs, helping to monitor the recovery of ESA-listed species, and monitoring changes in the marine environment important to the recovery of these species. Overall, the impact of NWFSC research on ESA-listed salmonids under the Status Quo Alternative is considered minor adverse according to the impact criteria described in Table 4.1-1.

For most species targeted by commercial fisheries and managed under FMPs, mortality due to research surveys and projects is less than ten percent of commercial harvest and less than one percent of OFLs and is considered to be minor in magnitude for all species. For a few species which do not have a large commercial market due to various market conditions or past overfishing, the research catch exceeds ten percent of commercial catch but is still less than one percent of OFL for each species and is considered minor in magnitude. Proposed research projects that target stocks that are overfished or where overfishing is occurring are reviewed annually before research permits are issued to determine if they would conflict with rebuilding plans or present other conservation concerns. Mortality for all species would be distributed across a wide geographic area rather than concentrated in particular localities. The overall effects of the Status Quo Alternative on non-ESA-listed fish would be minor in magnitude, distributed over a wide geographic area, and temporary or short-term in duration and would therefore be considered minor adverse according to the criteria in Table 4.1-1.

In contrast to these adverse effects, NWFSC research also provides long-term beneficial effects on managed fish species throughout the West Coast Region through its contribution to sustainable fisheries management. Data from NWFSC-affiliated research provides the scientific basis to reduce bycatch, establish optimal fishing levels, prevent overfishing, and recover overfished stocks. The beneficial effects of the time-series data provided by NWFSC research programs effects are especially valuable for long-term trend analysis for commercially harvested fish and, combined with other oceanographic data collected during fisheries research, provide the basis for monitoring changes to the marine environment important to fish populations.

4.2.4 Effects on Marine Mammals

Section 3.2.2 describes the marine mammals that are likely to overlap with fishery research activities in the three NWFSC research areas. This section describes the potential effects of the NWFSC research activities on marine mammals under the Status Quo Alternative, including measures that have been implemented in the past to mitigate those effects. Because the secondary federal action considered in this DPEA is the promulgation of regulations and subsequent issuance of LOAs under Section 101(a)(5)(A) of the MMPA, this section provides more information and analysis for effects on marine mammals than is presented for the analysis of effects on other resources.

Potential effects of fishery research vessels, survey gear, sonar and other active acoustic devices, and other associated equipment on marine mammals include:

- Disturbance and behavioral changes due to acoustic equipment and the physical presence of researchers
- Injury or mortality due to ship strikes
- Injury or mortality due to entanglement in gear
- Changes in food availability due to research removal of prey and discards

- Contamination from discharges

The first part of this section provides information on the mechanisms for these different types of effects. For those effects for which the mechanisms and levels of impact are similar for all species of marine mammals, the analysis is not repeated in the following research area and species subsections (4.2.4.1, 4.2.4.2, and 4.2.4.3).

The second part of the analysis provides information on the effects of the NWFSC research activities on marine mammals and their habitat in each research area. An application for Incidental Take Authorization under the MMPA (referred to in this document as the LOA application) must include estimates of the numbers of animals that may be taken by serious injury or mortality, harassment that has the potential to injure (Level A harassment takes), and harassment that has the potential to disturb (Level B harassment takes). The NWFSC LOA application (Appendix C) only concerns the Preferred Alternative because that is the NWFSC's proposed action. However, the analysis of takes in the LOA application is based on essentially the same scope of research activities as the Status Quo Alternative and is therefore helpful in describing the potential effects of the Status Quo Alternative. For those research areas and marine mammal species where the effects of the Status Quo are considered the same or very similar to the Preferred Alternative, analysis provided in the LOA application is summarized and referenced in this section. Where the scope of activities differs between the Status Quo and Preferred Alternatives, the analysis of effects from the LOA application are summarized and referenced in the Preferred Alternative (Section 4.3.5). The following analysis focuses on the types of research gear most likely to have adverse interactions with marine mammals.

Disturbance and Behavioral Responses due to Acoustic Equipment

Several mechanisms exist by which research activities could potentially disturb marine mammals and alter behavior, including the physical presence of marine vessels and fishing gear combined with operational sounds from engines, hydraulic gear, and acoustical devices used for navigation and research. The impacts of anthropogenic noise on marine mammals have been summarized in numerous articles and reports including Richardson et al. (1995), NRC (2005), and Southall et al. (2007). Marine mammals use hearing and sound transmission to perform vital life functions. Sound (hearing and vocalization/echolocation) serves four primary functions for marine mammals, including: 1) providing information about their environment, 2) communication, 3) prey detection, and 4) predator detection. Introducing sound into their environment could disrupt those behaviors. The distances to which anthropogenic sounds are audible depend upon source levels, frequency, ambient noise levels, the propagation characteristics of the environment, and sensitivity of the marine mammal (Richardson et al. 1995).

In assessing potential effects of noise, Richardson et al. (1995) suggested four criteria for defining zones of influence:

- Zone of audibility – the area within which the marine mammal might hear the sound. Marine mammals as a group have functional hearing ranges of 10 hertz (Hz) to 180 kilohertz (kHz), with highest sensitivities to sounds near 40 kHz (Ketten 1998, Kastak et al. 2005, Southall et al. 2007). These data show reasonably consistent patterns of hearing sensitivity within each of four groups: baleen whales, small odontocetes (such as the harbor porpoise), medium-sized odontocetes (such as the beluga and killer whales), and pinnipeds.
- Zone of responsiveness – the area within which the animal reacts behaviorally or physiologically. The behavioral responses of marine mammals to sound depend on: 1) acoustic characteristics of the noise source; 2) physical and behavioral state of animals at time of exposure; 3) ambient acoustic and ecological characteristics of the environment; and 4) context of the sound (e.g., whether it sounds similar to a predator) (Richardson et al. 1995, Southall et al. 2007). Temporary behavioral effects, however, often merely show that an animal heard a sound and may not

indicate lasting consequences for exposed individuals (Southall et al. 2007). Recent analysis of potential causes of a mass stranding of 100 typically oceanic melon-headed whales (*Peponocephala electra*) in Madagascar in 2008 implicate a mapping survey using a high-power 12 kHz multi-beam echosounder (MBES) as a likely trigger for this event. Although the cause is equivocal and other environmental, social, or anthropogenic factors may have facilitated the strandings, the authors determined the MBES the most plausible factor initiating the stranding response, suggesting that avoidance behavior may have led the pelagic whales into shallow, unfamiliar waters (Southall et al. 2013).

Factors that may affect the response of a marine mammal to a given noise generally cannot be determined ahead of time. In lieu of having this information, NMFS uses a standardized noise level to help determine how many animals may be disturbed (harassed) by a given activity during the MMPA authorization process. NMFS currently uses a sound threshold of 160 decibels (dB) referenced to 1 micro Pascal (μ Pa) (root mean square, rms) for impulse noises to determine the onset of behavioral harassment for marine mammals (Level B harassment takes) (NMFS 2005).

- Any animal exposed to impulse noises above this level is assumed to respond in a way consistent with the definition of a behavioral “take” under the MMPA, although NMFS acknowledges that some marine mammals may react to sounds below this threshold and that some animals exposed to sounds at or above this threshold may not react in ways consistent with behavioral harassment.
- Zone of masking – the area within which the noise may interfere with detection of other sounds, including communication calls, prey sounds, or other environmental sounds.
- Zone of hearing loss, discomfort, or injury – the area within which the received sound level is potentially high enough to cause discomfort or tissue damage to auditory or other systems. Underwater sounds produced by the active acoustic equipment used during NWFSC research have several characteristics (e.g., frequency, pulse duration, directionality, and power level) that make them highly unlikely to produce hearing loss or injury (Level A harassment) in marine mammals, which is an issue of concern for industrial and military actions.

The NWFSC has been using a variety of sonar systems during its research cruises to characterize marine habitats and fish aggregations. The sounds produced by equipment used by the NWFSC range from 18-330 kHz and from <200 dB to 224 dB referenced to 1 μ Pa (Appendix C, Section 6.2). This acoustic equipment sends pulses of sound into the marine environment which provide information as they reflect back to the ship and are recorded (see Appendix A for a more detailed description of active acoustic instruments used in NWFSC research, including frequency ranges, beam width, source power levels, and other sound characteristics). The LOA application (Appendix C, Section 6.2) categorized active acoustic sources used by the NWFSC during research based on operating frequency and output characteristics. Category 1 active acoustic sources include short range echosounders and acoustic Doppler current profilers (ADCPs). These have output frequencies >300 kilohertz (kHz), are generally of short duration, and have high signal directivity. Category 2 active acoustic sources include various single, dual, and multi-beam echosounders, devices used to determine trawl net orientation, and current profilers of lower output frequencies than category 1 sources. Output frequencies of category 2 sources range from 12 to 200 kHz, have short ping durations, and are usually highly directional for mapping purposes.

Although these acoustic systems have been used for years and may have been a source of disturbance for nearby marine mammals, no direct observations of disturbance have been documented, primarily because any such disturbance, if it occurred, would have taken place under water. For animals at the surface, it is very difficult to determine whether a given sound source has caused any observed changes in behavior or whether the physical presence of the vessel has caused the disturbance. In many cases it is likely to be a combination of visual and audio components that causes a disturbance. It may also be difficult to determine if an animal has actually changed its behavior to avoid a disturbance or if it is moving for other

reasons (e.g., to pursue nearby prey). For these reasons there have been no records or documentation of how many animals may have been disturbed (Level B harassment) by sounds generated from acoustic equipment during research cruises in the past. However, the MMPA requires applicants who are requesting authorization for incidental take of marine mammals to estimate how many animals may be affected by their actions.

NMFS regulations for implementing the MMPA distinguish between Level B harassment that causes behavioral changes in the affected marine mammals and Level A harassment that has the potential to cause injury. Animals exposed to intense sounds may experience reduced hearing sensitivity for some period of time following exposure. This change in hearing threshold is known as noise induced threshold shift (TS). The amount of TS incurred is influenced by amplitude, duration, frequency content, temporal pattern, and energy distribution of the noise (Richardson et al. 1995, Southall et al. 2007). It is also influenced by characteristics of the animal, such as hearing range of the species, behavior, age, history of noise exposure, and health. The magnitude of TS generally decreases over time after noise exposure and if it eventually returns to zero, it is known as ‘temporary threshold shift’ (TTS). If TS does not return to zero after some time (generally on the order of weeks), it is known as ‘permanent threshold shift’ (PTS). Sound levels associated with TTS onset are generally considered to be below the levels that will cause PTS, which is considered to be auditory injury.

The current NMFS policy regarding Level A harassment is that cetaceans should not be exposed to impulsive sounds greater than 180 dB re 1 μ Pa (rms) and that pinnipeds should not be exposed to impulsive sounds greater than 190 dB re 1 μ Pa (rms) (65 FR 39874, June 28, 2000). However, these criteria were established before information was available about minimum received levels of sound that would cause auditory injury in marine mammals. They are likely lower than necessary and are intended to be precautionary estimates above which physical injury may occur (Southall et al. 2007).

In an extensive review of the effects of noise on marine mammal hearing and behavior, Southall et al. (2007) suggest that relatively high levels of sound are likely required to cause temporary hearing threshold shifts (TTS) in most pinnipeds and odontocete cetaceans (e.g., Schlundt et al. 2000; Finneran et al. 2002, 2005, 2007b, 2010a and b; Kastak et al. 1999, 2005, 2007). Based on the results of these studies, peak sound pressure levels in the range of approximately 180-220 dB re: 1 μ Pa are required to induce onset of TTS for most species; the TTS onset values for harbor seals in air ranged from 135 to 149 dB re: 20 μ Pa (Southall et al. 2007). PTS onset criteria, based on sound pressure level, for individual marine mammals exposed to discrete single pulse, multiple pulse, or non-pulse noise events were derived by adding 6 dB to peak pressure levels known or assumed to elicit TTS-onset. Resulting values are 230 dB re: 1 μ Pa for cetaceans, 281 dB re: 1 μ Pa for pinnipeds in water, and 149 dB re: 20 μ Pa for pinnipeds in air (Southall et al. 2007). Southall et al. (2007) also provided some frequency weighting functions for different marine mammal groups to account for the fact that impacts of noise on hearing depend in large part on the overlap between the range of frequencies in the sound source and the hearing range of the species. Based on the Southall et al. (2007) results, Lurton and DeRuiter (2011) modeled the potential impacts (PTS and behavioral reaction) of conventional echosounders on marine mammals. They estimated PTS onset at typical distances of 10 to 100 meters for the kinds of acoustic sources used in fisheries surveys considered here. They also emphasized that these effects would very likely only occur in the cone insonified below the ship and that behavioral responses to the vessel at these extremely close ranges would very likely influence the probability of animals being exposed to these levels.

Animals are likely to avoid a moving vessel, either because of its physical presence or because of behavioral harassment resulting from exposure to sound from active acoustic sources. It is unlikely that animals would remain in the presence of a harassing stimulus absent some overriding contextual factor. Because of this likely avoidance behavior, as well as the source characteristics (i.e., intermittent pulsing and narrow cones of ensonification), the NWFSC has determined that the risk of animals experiencing repetitive exposures at the close range or of the duration necessary to cause PTS is negligible. The

NWFSC therefore does not anticipate causing any Level A harassment by acoustic sources of marine mammals and the LOA application includes no such take estimates. The potential for this type of impact on marine mammals will not be discussed further in this DPEA.

However, the NWFSC recognizes that the use of active acoustic equipment in its research activities has the potential to cause Level B harassment of marine mammals. In its LOA application for the Preferred Alternative, the NWFSC estimated the numbers of marine mammals that may be exposed to sound levels of 160 dB (rms) or above due to the use of acoustic sonars during research cruises (Level B harassment takes). The LOA application used the operational conditions and scope of work conducted in the past five years to estimate what may occur in the future under the Preferred Alternative. The Preferred Alternative would include a few changes in the NWFSC surveys and research projects relative to the Status Quo Alternative (Table 2.3-1). Under the Preferred Alternative, active acoustics will be added to the Newport Line Plankton Survey, although the types of acoustic devices and protocols used do not differ from those employed under the Status Quo Alternative. The acoustic take estimates presented in the LOA application therefore also represent potential numbers of animals affected under the status quo conditions.

As explained in the LOA application, these estimates attempt to quantify a dynamic situation with substantial unavoidable uncertainty regarding the propagation of sound in the water and distribution of marine mammals over very large areas. The scientific description of sound generated by sonar gear and its propagation through water is complicated, especially considering a sound source that is moving (on a vessel) through waters of different depths and properties (e.g. salinity and temperature) that affect sound transmission. The LOA application provides details on the assumptions that were made about the source levels and acoustic properties of sonar pulses, the directionality of the sound, and propagation/attenuation properties that were used to calculate an “insonified area” considered loud enough to harass marine mammals. One part of the NWFSC acoustic take calculation used a model of sound propagation from typical sonar equipment used during research to estimate the shape and dimensions of a typical insonified zone ≥ 160 dB re 1 μ Pa (rms), which was multiplied by the distance research ships travel with active sonar gear to derive an estimated total area insonified to the Level B harassment take guidelines.

Another aspect of this Level B harassment take estimation process subject to large uncertainty concerns the distribution and abundance of marine mammals in the area. No species is distributed evenly throughout its range; they are typically patchy in distribution with strong seasonal variations and preferences for certain zones within the water column. Although some preferred habitats and general distributions are known, it is not possible to know precisely how many animals will be in a given area at any point in the future. The estimation process therefore uses average density of each species within the CCRA (the only research area in which NWFSC uses active acoustics for research) to estimate how many may be affected within the insonified area. One refinement that has been built into the Level B harassment take model is to categorize each marine mammal species according to its typical dive depth range, which affects the size of the insonified zone to which they may be exposed (Appendix C). The estimation process is admittedly subject to great uncertainty and there is no way to assess how realistic these estimates are in terms of the number of animals that would be disturbed by the activity. However, development of the Level B harassment take model was conservative in that assumptions made would tend to overestimate the size of the insonified area and the number of animals affected.

This DPEA (and the LOA application) must also assess what the likely biological effects may be for the estimated Level B harassment takes by acoustic sources. The LOA application (Appendix C, Section 7.2.2) provides an analysis of the potential effects of acoustic equipment used in NWFSC research on marine mammals. The analysis in this DPEA is a summary of the LOA application analysis and will be provided in the subsections on cetaceans and pinnipeds because their different hearing ranges and frequencies used for communication determine what the effects of different acoustic equipment might be. This effort to examine the biological importance of acoustic disturbance requires knowledge about whether animals can perceive the sonar signals, their potential reactions to various types of sounds, and

the conditions under which particular sound sources may lead to biologically meaningful effects (i.e. interference with feeding opportunities or critical social communication). Many key aspects of marine mammal behavior relevant to this discussion are, however, poorly understood. Most of the data on marine mammal hearing and behavioral reactions to sound come from relatively few captive, trained animals and likely does not reflect the diversity of behaviors in wild animals. Some behavioral reactions, if they occur in one or more species, could substantially reduce the numbers of animals exposed to high sound levels (e.g. swimming away from an approaching ship before sound levels reach the 160 dB rms level). Industrial projects such as seismic exploration for oil and gas and pile driving in relation to coastal developments are typically required to monitor marine mammal behavioral responses in relation to percussive industrial sounds but there have been few efforts to document behavioral changes in response to acoustic equipment commonly used in fisheries research.

Injury or Mortality due to Ship Strikes

The Pacific coast of the U.S., Puget Sound, and the Lower Columbia River encompass numerous shipping lanes, active ports, and vessel traffic. Vessel collisions with marine mammals, or ship strikes, can lead to death by massive trauma, hemorrhaging, broken bones, or propeller wounds (Knowlton and Kraus 2001). Large whales, such as fin whales, are occasionally found draped across the bulbous bow of large ships upon arriving in port. Massive propeller wounds can be immediately fatal. If more superficial, the whales may survive the collisions (Silber et al. 2009). Jensen and Silber (2003) summarized large whale ship strikes world-wide and found that most collisions occurred in the open ocean involving large vessels. Commercial fishing vessels were responsible for four of 134 records (three percent), and one collision (0.75 percent) was reported for a research boat, pilot boat, whale catcher boat, and dredge boat. Along the Washington coast, fin whales had the highest incidence of ship-strike mortality. All of the fin whales in this study, including several draped across ship bows, were recovered (dead) in inland waters of Puget Sound and the Columbia River. The fin whales were most likely struck by large ships on or near the continental shelf and, subsequently, transported into port on the vessels' bows (Douglas et al. 2008).

Vessel speed appears to be key in determining the frequency and severity of ship strikes, with the potential for collision increasing at ship speeds of 15 knots (kts) and greater (Laist et al. 2001, Vanderlaan and Taggart 2007). In the relatively few recorded cases of ship strikes at speeds below 15 kts, the chance of mortality declines from approximately 80 percent at 15 kts to approximately 20 percent at 8.6 kts (Vanderlaan and Taggart 2007). Relatively high rates of blue whale and other large whale mortalities from ship strikes along the California coast in recent years led to increased efforts to map high risk traffic zones and develop mitigation technologies and strategies for those areas (Abramson et al. 2009). Voluntary ship speed restrictions in the Santa Barbara Channel have not been very effective in reducing average ship speeds in this high-risk ship strike area but adaptive management strategies with real-time monitoring of whale presence and ship locations may be more effective in reducing risks of ship strikes (Abramson et al. 2009). Among the management strategies is a change in the shipping lanes off Southern and Central California. Based on collaborative efforts of a number of groups, agencies, and the U.S. Coast Guard, the International Maritime Organization (IMO) amended shipping lane approaches to the Los Angeles, Long Beach, and San Francisco Bay ports to reduce the co-occurrence of whales and ships in the San Francisco Bay area and in the Santa Barbara Channel, effective June 2013 (NOAA Sanctuaries 2013). Reducing the co-occurrence of whales and vessels may be the only sure way to reduce ship strikes, but this is not always feasible (Silber et al. 2009).

No collisions with large whales have been reported from any fisheries research activities conducted or funded by the NWFSC. Transit speeds vary from 6-14 kts, but average 10 kts. The vessel's speed during active sampling is typically 2-4 kts due to sampling design and these much slower speeds essentially eliminate the risk of ship strikes.

Given the relatively slow speeds of research vessels, the presence of bridge crew watching for marine mammals during survey activities, and the small number of research cruises, ship strikes with marine mammals during the research activities described in this DPEA would be considered rare in frequency, localized in geographic scope, and unlikely to occur in the near future. The potential for fisheries research vessels to cause serious injury or mortality to any cetaceans or pinnipeds due to ship strikes is considered minor adverse throughout the NWFSC research areas using vessel types and protocols currently in use. This potential effect of research will not be discussed further in the following analysis.

Injury or Mortality due to Entanglement in Fishing Gear

Entanglement and capture in fishing gear is a significant source of human-caused injury or mortality for some marine mammals. Although not always as immediately fatal as ship strikes, entanglements can lead to prolonged weakening or deterioration of an animal (Knowlton and Kraus 2001). This is particularly true for large whales; small whales, dolphins, porpoises, and pinnipeds are more likely to die when entangled.

Commercial fisheries along the U.S. West Coast with known bycatch of marine mammals include those using pelagic longlines, other hook-and-line gears, set gillnets, drift gillnets, trawls, pot gear, and purse seines (Carretta et al. 2013). Further details regarding specific fisheries and marine mammal bycatch will be discussed when considering cumulative effects (Section 5.3.2). Several of these gear types are employed during NWFSC fisheries research surveys, including bottom and mid-water trawls, surface trawls, hook-and-line gears, gillnets, beach and purse seines, tangle nets, and pots (Appendix A and B).

The 1994 amendments to the MMPA tasked NMFS with establishing monitoring programs to estimate mortality and serious injury of marine mammals incidental to commercial fishing operations and to develop Take Reduction Plans (TRPs) in order to reduce commercial fishing takes of strategic stocks of marine mammals below Potential Biological Removal (PBR). The Pacific Offshore Cetacean Take Reduction Plan (POCTRP) was finalized in 1997 to reduce the level of mortality and serious injury of several marine mammal stocks, including beaked, pilot, pygmy sperm, sperm, and humpback whales, in the California/Oregon drift gillnet fishery for thresher shark and swordfish (62 FR 51805). Data from 2008-2009 indicated that the POCTRP achieved the MMPA short term goal of reducing serious injuries and mortalities of all strategic stocks to below PBR and the long term goal of reducing serious injuries and mortalities of all marine mammals (except long-beaked common dolphins) to insignificant levels (POCTRT 2009). This is the only TRP relevant to waters of the CCRA, but it is not relevant for NWFSC research operations since NWFSC does not employ drift gillnet gear. Additional details on the POCTRP are included in Section 5.5.1.

All incidental takes of marine mammals during NWFSC fisheries research from 1999 to 2014 involved trawl gear. Forty takes occurred in Nordic 264 surface trawls and two takes were in a modified Cobb trawl (Table 4.2-14 and Figure 4.2-1). Species involved were Pacific white-sided dolphins (24), Steller sea lions (8), California sea lions (4, including one released alive), harbor seals (3, including one released alive), northern fur seal (1), and unidentified porpoise/dolphin (2). Most (33) takes occurred during Juvenile Salmon PNW Coastal Surveys. The three other surveys with reported marine mammal takes are the Juvenile Rockfish Survey (2), the Skagit Bay Juvenile Salmon Survey (1), and the PNW Piscine Predator and Forage Fish Survey (6). This last survey is part of the Status Quo but is not longer conducted. The NWFSC has made a concerted effort to develop and implement mitigation measures to reduce the risk of such takes. These mitigation measures are part of the Status Quo Alternative and are described in Section 2.2.1. The take of the six Pacific white-sided dolphins in the Juvenile Salmon Survey in 2014 prompted emergency rules with immediate incorporation of a marine mammal excluder device (MMED) for trawls conducted with the Nordic 264. The MMED was used on all trawls subsequent to the take of the six dolphins. The NWFSC continues to modify and test different configurations of the device and to run calibration experiments to align catch data on trawls with the MMED to historic catch data sets

without the MMED. Use of the MMED on Nordic 264 trawls is part of the Preferred Alternative (Section 2.3.2).

Most of the mitigation measures rely on visual monitoring and detection of marine mammals near the vessel or fishing gear. There are many variables that influence the effectiveness of visual monitoring at any one time, including the lighting and sea state and the capabilities of the person(s) assigned to watch, so it is impossible to determine an overall measure of effectiveness, such as how many animals may have been avoided with visual monitoring compared to having no monitors. The value of implementing some mitigation measures is therefore based on general principles and best available information even if their effectiveness at reducing takes has not been scientifically demonstrated.

Figure 4.2-1 shows the spatial distribution of marine mammals that have been taken in NWFSC surveys from 1999 through 2014, and Table 4.2-14 indicates the date and time of interaction. These historical takes are dispersed fairly widely and there does not appear to be any spatial pattern of high risk areas (i.e., “hot spots” for marine mammal takes) or any temporal pattern with regard to seasons or times of day.

The MMPA authorization process requires the applicant (NWFSC) to estimate how many marine mammals may be captured or entangled in the future under the proposed set of conditions. As is the case for Level B harassment takes by acoustic sources, the LOA application (Appendix C) describes the methodology used to estimate the species and numbers of animals that may be taken by Level A harassment and serious injury or mortality during future research conducted under the Preferred Alternative. The LOA application combines estimated Level A harassment takes with serious injury or mortality takes because the degree of injury resulting from gear interaction cannot be predicted. The lethal take estimates are based on the past history of takes (both lethal takes and animals captured and released alive) by the NWFSC under the status quo conditions. For the species that have been taken historically during NWFSC research, the LOA application uses the calculated average annual numbers of takes that occurred in the past fifteen years (1999-2014) and “rounds up” this annual average to the next highest whole number of animals. For example, an average of 0.3 animals per year was rounded up to one animal. Since the LOA application requests takes for a five-year period, this intentionally inflated annual average is multiplied by five to produce an estimate higher than the historic average take for each species that has been taken incidentally during NWFSC research. This methodology has been used for all species except Pacific white-sided dolphins in order to ensure accounting for a precautionary amount of potential take in the future.

Potential takes of Pacific white-sided dolphins are based on a worst-case scenario instead of the average-based approach. Pacific white-sided dolphins are the most frequently caught marine mammal species in NWFSC fisheries research surveys. All of the 24 takes between 1999 and 2014 were lethal and most occurred in the Juvenile Salmon PNW Coastal Survey (Table 4.2-14). All but one incident where Pacific white-sided dolphins were caught involved more than one animal caught in a single trawl; the maximum number caught in a single set was six during a 2014 Juvenile Salmon PNW Coastal Survey. Because of the high abundance and wide distribution of this species in the CCRA, their tendency to travel and hunt in close pods, and the high frequency of multi-animal captures in the past, the average-based approach described above does not adequately represent a precautionary level of predicted take of Pacific white-sided dolphins. For this species, estimated take levels were based on a “worst case scenario” of catching a high number of dolphins each year. The LOA application takes the highest number of Pacific white-sided dolphins taken in a single set (six animals in 2014) and assumes this level of take could occur each year as the basis for the annual take estimate. This level of take is multiplied by five to get an estimate of 30 takes over the 5-year authorization period.

The LOA application (Appendix C) also includes estimates for future incidental takes of species that have not been taken historically but exist in the same areas and show similar vulnerabilities as species that have been taken in the past. Factors considered when determining if a species may have similar vulnerabilities to certain types of gear as historically taken species include density, abundance, behavior, feeding

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4.2 Direct and Indirect Effects of Alternative 1 – No Action/Status Quo Alternative

ecology, group size and composition, and association with species historically taken. For these analogous species, the NWFSC estimates the annual take to be equal to the maximum take per any given set of a similar species that was historically taken during 1999-2014. This method is based on the assumption that such takes would likely occur rarely, if at all, but may involve more than one animal in a given trawl or set given the social nature of many marine mammals.

The NWFSC has no history of marine mammal takes in hook-and-line gear (including longlines, rod and reel, and trolling deployments) or purse seine or tangle net gear, so all requested takes are based on takes in analogous commercial fishing operations. For analogous commercial fisheries, the NWFSC referenced the 2014 List of Fisheries. Several additional factors were also considered in determining the likelihood of cetacean interactions with hook-and-line and purse seine gear in the CCRA, including relative survey effort, survey location, similarity in gear type, and animal behavior. There are several species, such as large whales, that are known to interact with commercial longline fisheries but for which NWFSC is not requesting take. Most of the NWFSC research effort with hook-and-line gear is with rod and reel deployments, not longlines, and the likelihood of interacting with NWFSC gear is extremely low considering the low level of survey effort relative to that of commercial fisheries.

Table 4.2-14 Historical Takes of Marine Mammals during NWFSC Surveys from 1999 through 2014

Survey Name	Protected Species Taken	Gear Type	Date (Time) Taken	# Killed	# Released Alive ¹	Total Taken
2014						
Juvenile Salmon PNW Coastal Survey	Pacific white-sided dolphin	Nordic 264 Surface Trawl	21 June (15:46)	6	0	6
2012						
Juvenile Salmon PNW Coastal Survey	Pacific white-sided dolphin	Nordic 264 Surface Trawl	28 June (15:35)	3	0	3
2010						
Juvenile Salmon PNW Coastal Survey	Harbor seal	Nordic 264 Surface Trawl	24 May (08:44)	1	0	1
2009						
Northern Juvenile Rockfish Survey	California sea lion	Modified Cobb Mid-Water Trawl	26 May (06:26)	1	1	2
Juvenile Salmon PNW Coastal Survey	Unidentified porpoise or dolphin ²	Nordic 264 Surface Trawl	23 May (14:48)	2	0	2
Skagit Bay Juvenile Salmon Survey	Harbor seal (OR-WA Coastal stock)	Nordic 264 Surface Trawl	16 May (10:50)	0	1	1
2007						
Juvenile Salmon PNW Coastal Survey	California sea lion	Nordic 264 Surface Trawl	28 September (08:15)	1	0	1

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Survey Name	Protected Species Taken	Gear Type	Date (Time) Taken	# Killed	# Released Alive ¹	Total Taken
2006						
PNW Piscine Predator and Forage Fish Survey	Pacific white-sided dolphin	Nordic 264 Surface Trawl	28 August (05:00)	2	0	2
PNW Piscine Predator and Forage Fish Survey	Pacific white-sided dolphin	Nordic 264 Surface Trawl	1 June (05:35)	3	0	3
2005						
Juvenile Salmon PNW Coastal Survey	Pacific white-sided dolphin	Nordic 264 Surface Trawl	18 June (16:30)	3	0	3
2003						
Juvenile Salmon PNW Coastal Survey	Pacific white-sided dolphin	Nordic 264 Surface Trawl	25 June	1	0	1
Juvenile Salmon PNW Coastal Survey	Harbor seal	Nordic 264 Surface Trawl	30 June	1	0	1
Juvenile Salmon PNW Coastal Survey	Pacific white-sided dolphin	Nordic 264 Surface Trawl	30 June (20:24)	2	0	2
2002						
Juvenile Salmon PNW Coastal Survey	Steller sea lion	Nordic 264 Surface Trawl	22 September	1	0	1
Juvenile Salmon PNW Coastal Survey	Steller sea lion	Nordic 264 Surface Trawl	23 September	1	0	1
Juvenile Salmon PNW Coastal Survey	Steller sea lion	Nordic 264 Surface Trawl	24 September (17:56)	2	0	2
2001						
PNW Piscine Predator and Forage Fish Survey³	California sea lion	Nordic 264 Surface Trawl	19 July	1	0	1
2000						
Juvenile Salmon PNW Coastal Survey	Northern fur seal	Nordic 264 Surface Trawl	18 May	1	0	1
1999						
Juvenile Salmon PNW Coastal Survey	Pacific white-sided dolphin	Nordic 264 Surface Trawl	24 May (21:36)	4	0	4
Juvenile Salmon PNW Coastal Survey	Steller sea lion	Nordic 264 Surface Trawl	29 September (12:35)	1	0	1
Juvenile Salmon PNW Coastal Survey	Steller sea lion	Nordic 264 Surface Trawl	1 October (06:12)	3	0	3
TOTAL						
				40	2	42

1. Serious injury determinations were not previously made for animals released alive, but will be part of standard protocols for released animals after such incidental takes are authorized and will be reported in Stock Assessment Reports.
2. The unidentified porpoises/dolphins were released from gear in unknown condition, so were assigned to mortality/serious injury status.
3. Survey discontinued under the Preferred Alternative.

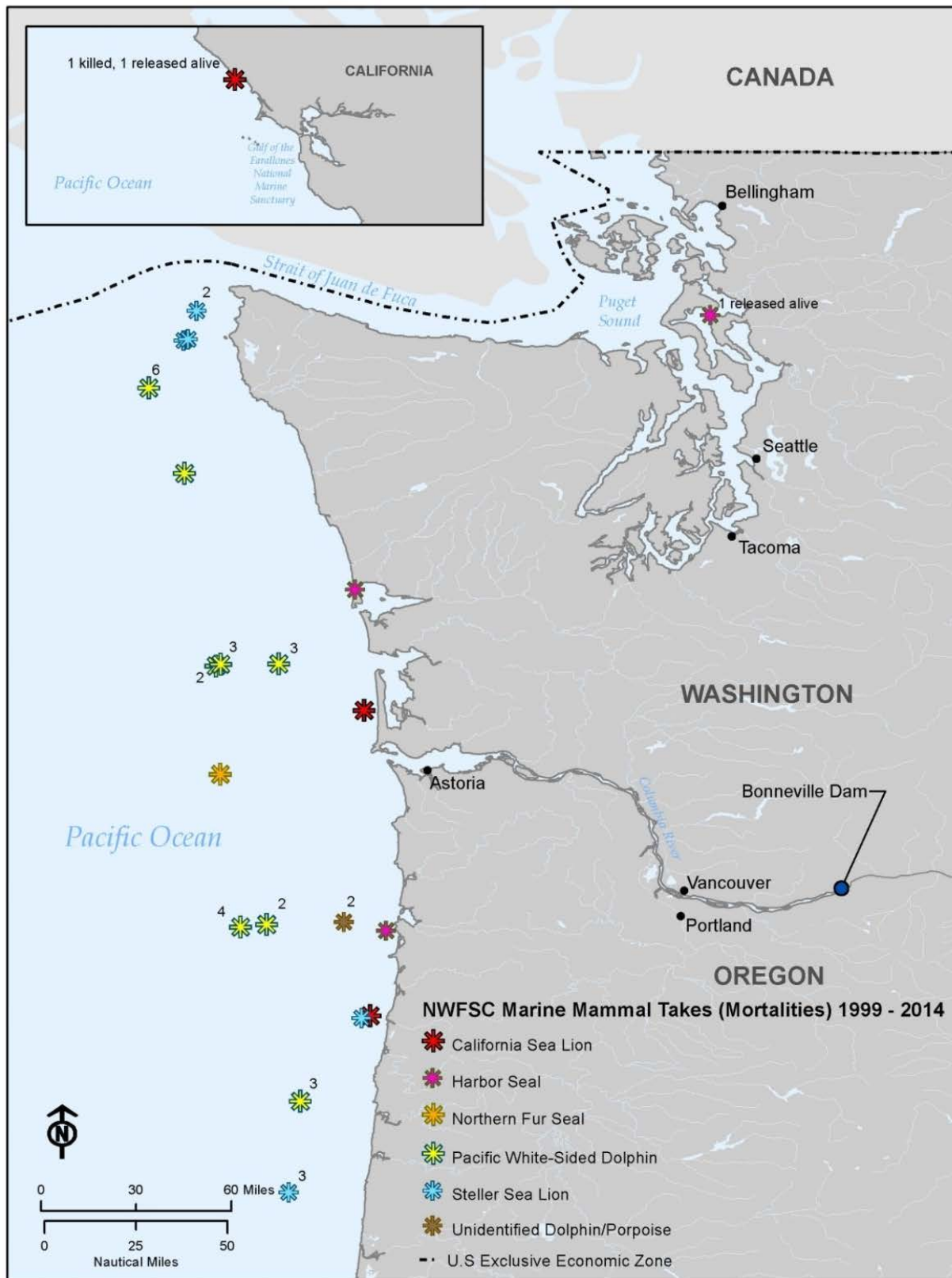


Figure 4.2-1 Location of Marine Mammal Takes during NWFSC Research from 1999 to 2014

Changes in Food Availability due to Research Survey Removal of Prey and Discards

Prey of marine mammals varies by species, season, and location and, for some, is not well documented. There is some overlap in prey of marine mammals in the NWFSC research areas and the species sampled and removed during fisheries research surveys. The species of primary concern in regard to this overlap are Pacific hake (whiting), the small, energy-rich, schooling species such as Northern anchovy and Pacific herring, and salmonids. However, the total amount of these species taken in research surveys is very small relative to their overall commercial and recreational catches and biomass, when known (See Section 4.2.3 for more information on fish caught during research surveys).

In addition to the small total biomass taken, some of the size classes of fish targeted in research surveys are very small (e.g., juvenile salmonids only centimeters long) and these small size classes are not generally targeted by marine mammals. Research catches are also distributed over a wide area because of random sampling designs and other sampling protocols that take small samples within large sample areas. Fish removals by research are therefore highly localized and unlikely to affect the spatial concentrations and availability of prey for any marine mammal species. This is especially true for pinnipeds, which are opportunistic predators that consume a wide assortment of fish and squid and, judging by their increasing populations and expanding ranges in the Pacific Northwest (Caretta et al. 2011), food availability does not appear to be a limiting factor (Baraff and Loughlin 2000, Scordino 2010).

NWFSC fisheries research catch levels are very small relative to the estimated consumption of prey by marine mammals, dispersed over large areas and time periods, and are unlikely to affect changes in prey type or quantity available to any marine mammals. The potential for NWFSC research to affect the availability of prey to marine mammals is considered to be minor adverse for all species and all three research areas and it will not be discussed further.

Contamination from Discharges

Discharge from vessels, whether accidental or intentional, include sewage, ballast water, fuel, oil, miscellaneous chemicals, garbage, and plastics. Impacts to marine mammals in the vicinity of the discharge range from superficial exposure to ingestion and related effects. Even at low concentrations that are not directly lethal, some contaminants can cause sub-lethal effects on sensory systems, growth, and behavior of animals, or may be bioaccumulated (DOE 2008).

All NOAA vessels and NWFSC chartered vessels are subject to the regulations of MARPOL 73/78, the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 (NOAA 2010b). MARPOL includes six annexes that cover discharge of oil, noxious liquid substances, harmful packaged substances, sewage, garbage, and air pollution (IMO 2010). Adherence to these regulations minimizes or negates the likelihood of discharges of potentially harmful substances into the marine environment. Annex V specifically prohibits plastic disposal anywhere at sea and severely restricts discharge of other garbage (IMO 2010).

Discharge of contaminants from NWFSC vessels and NWFSC chartered vessels is possible, but unlikely to occur in the next five years. If an accidental discharge does occur, it is likely to be a rare event and the potential volume of material is likely to be small and localized. The potential impacts to marine mammals would be similarly short-term, localized, and likely affect a small number of animals. The overall impact of accidental contamination of marine mammals would therefore be considered minor adverse. As the potential effects of discharges, regulations governing discharges, and the likelihood of discharges is universal throughout the NWFSC research areas, this will not be discussed further in this analysis.

4.2.4.1 California Current Research Area

ESA-listed Species

The endangered marine mammals that occur in the CCRA include sperm, humpback, blue, fin, and sei whales and the Southern Resident Distinct Population Segment (DPS) of killer whales, and, periodically, individuals from the western North Pacific stock of gray whales. Threatened species include Guadalupe fur seals and the Southern subspecies of sea otter. Sea otters are under the jurisdiction of the U.S. Fish and Wildlife Service (USFWS), while the remainder is under the jurisdiction of NMFS in regards to compliance with the MMPA and ESA.

Disturbance and Behavioral Responses due to Acoustic Equipment

The LOA application (Appendix C) includes calculations of the number of marine mammals that may be exposed to sound levels above 160 dB from all acoustic devices used during NWFSC research activities in the CCRA. Those calculations include a number of assumptions and elements with large variables over time and space (e.g., the densities of marine mammals and the propagation of sound under different conditions). The NWFSC believes this quantitative approach benefits from its simplicity and consistency with current NMFS guidelines on estimating Level B harassment by acoustic sources, but cautions that the resulting take estimates should be considered as overestimates of behavioral harassment from acoustic devices. The DPEA reports the results of those estimates in Table 4.2-14, but see Appendix C for a discussion about the derivation and concerns about the accuracy of these estimates. The likely impact on ESA-listed species from the different types of acoustic devices is discussed below. Active acoustic systems are not used during research in the PSRA or the LCRRA, so there are no acoustic takes estimated for those research areas.

**Table 4.2-15 Estimated Level B Harassment Takes of Marine Mammals
by Acoustic Sources during NWFSC Research in the CCRA**

Species	Estimated take by all acoustic sources (numbers of animals)
Harbor porpoise ¹	110
Dall's porpoise	218
Pacific white-sided dolphin	61
Risso's dolphin	30
Bottlenose dolphin ¹	6
Striped dolphin	49
Short-beaked common dolphin	895
Long-beaked common dolphin	55
Northern right-whale dolphin	28
Killer whale ¹	2
Short-finned pilot whale	1
Baird's beaked whale	3
Mesoplodont beaked whales	3
Cuvier's beaked whale	14

Species	Estimated take by all acoustic sources (numbers of animals)
<i>Kogia</i> (pygmy and dwarf sperm whales)	3
Sperm whale ²	6
Humpback whale ²	2
Blue whale ²	4
Fin whale ²	6
Sei whale ²	0
Common Minke whale	2
Gray whale ¹	55
California sea lion	688
Steller sea lion, eastern DPS	169
Guadalupe fur seal ¹	22
Northern fur seal ¹	974
Harbor seal ¹	146
Northern elephant seal	431

1. Estimated take is for all stocks combined. Refer to Table 3.2-3 for stock delineations.

2. ESA-listed species

The output frequencies of Category 1 active acoustic sources (short range echosounders, Acoustic Doppler Current Profilers) are >300 kHz and are generally short duration signals with high signal directivity (Appendix C, Section 6.2). The functional hearing range of baleen whales is 7 Hz-30 kHz, with highest sensitivity generally below 1 kHz, and that of mid-frequency hearing odontocetes (e.g., sperm whales and killer whales) is 150 Hz-160 kHz, with highest sensitivity from 10-120 kHz. These functional hearing ranges fall below the output frequency of Category 1 sources, which are unlikely to be detected by right, humpback, fin, sei, blue, or sperm whales (Figure 4.2-2).

Category 2 active acoustic sources (various single, dual, and multi-beam echosounders, devices used to determine trawl net orientation and several current profilers) have frequencies of 12-200 kHz, short ping durations, and are usually highly directional. These are unlikely to be heard by most baleen whales, but are within the hearing range of sperm and killer whales. If detected, short term avoidance is the most likely response, which would tend to reduce the exposure of animals to high sound levels, so that the potential for direct physical injury is virtually zero (Appendix C, Section 6.2).

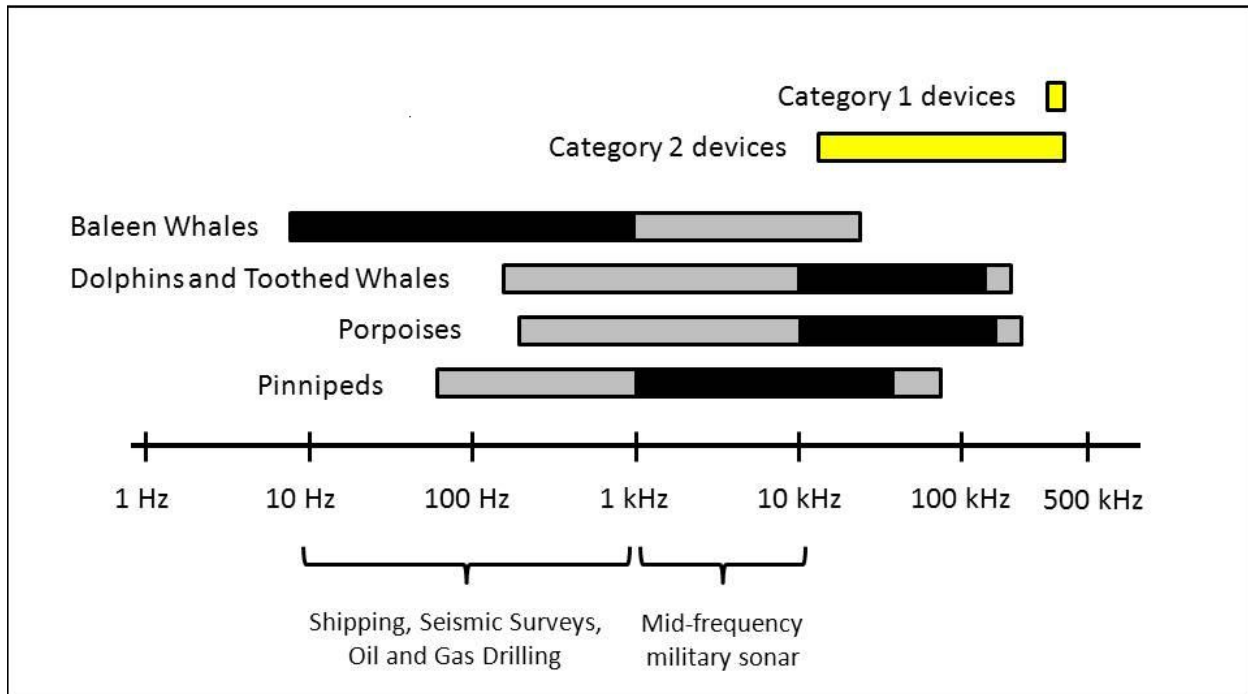


Figure 4.2-2 Typical Frequency Ranges of Hearing in Marine Mammals

Figure 4.2-2 shows hearing range relative to the frequency outputs of the two categories of acoustic devices used in NWFSC research (yellow bars), as identified in Appendix C, Section 6.2. Black bars indicate the most sensitive hearing ranges of different marine mammals. Data on hearing ranges is from Southall et al. (2007) and modified from DON (2008b). The functional hearing range of sea otters in water has not been determined.

The anticipated effects of active acoustic sources used during NWFSC fisheries research on threatened and endangered marine mammals is likely to occur infrequently, although they may occur over a large geographic area. Most of the frequencies are well above detection ranges for ESA-listed baleen whales, while Category 2 output overlaps with the hearing range of sperm whales. To date, there have been no reports or observations of sounds from NWFSC research activities disturbing or affecting behavioral changes in ESA-listed species.

Vessel noise may affect large whales through masking of biologically important sounds, particularly for low frequency baleen whales (Clark et al. 2009). The biological significance of masking from vessel noise is not known for any species but presumably the effects could include a decreased ability to detect sounds used in communication, predator avoidance, and orientation. However, the relatively small number of NWFSC research vessels is likely to only result in temporary and minimal effects from acoustic masking as vessels pass through an area (Appendix C, Section 6.2).

The potential effects from the use of active acoustic devices during research activities would be small in magnitude and short-term in duration, although they would be dispersed over a wide geographic area and be likely to occur under the Status Quo Alternative. The overall impacts of acoustic disturbance to ESA-listed marine mammals throughout the CCRA are therefore considered to be minor adverse.

Injury and Mortality due to Entanglement in Gear

Table 4.2-14 indicates marine mammal takes by all NWFSC research activities from 1999-2014. Between 1999 and 2002, there were eight takes of Steller sea lions which were, at the time of take, listed as threatened (Eastern DPS). The Eastern DPS of Steller sea lions was delisted in 2013. As a result, none of

the historical entanglements or takes of marine mammals in NWFSC fisheries research from NOAA vessels or NOAA chartered vessels are currently ESA-listed species. The NWFSC is not requesting the take of any ESA-listed cetaceans or pinnipeds by trawl gear due to lack of historical interactions and the low probability of take due to several factors, including density, abundance, and behavior. For similar reasons, the NWFSC also does not anticipate any future takes of southern sea otters, which are under the jurisdiction of the USFWS and are not covered in the LOA application to NMFS.

The NWFSC has no historical takes of marine mammals in its hook-and-line gear, although takes of marine mammals in commercial hook-and-line fisheries are well-documented. The 2014 List of Fisheries classifies commercial fisheries based on prior interactions with marine mammals. Although the NWFSC used this information to help make an informed decision on the probability of specific cetacean and large whale interactions with hook-and-line gear in the CCRA, many other factors were also taken into account (e.g., relative survey effort, survey location, similarity in gear type, animal behavior, prior history of NWFSC interactions with hook-and-line gear etc.). Therefore there are several species that have been shown to interact with commercial hook-and-line fisheries but for which NWFSC is not requesting take. For example, the NWFSC is not requesting take of large whales in hook-and-line gear. Although large whale species could become entangled in hook-and-line gear, the probability of interaction with NWFSC hook-and-line gear is extremely low considering a lower level of survey effort relative to that of commercial fisheries. Although data on commercial fishing effort are not publically available, based on the amount of fish caught by commercial fisheries versus NWFSC fisheries research, the “footprint” of research effort compared to commercial fisheries is very small.

Measures to mitigate the risk of entanglements are described in Section 2.2.1. Vessel captains, bridge officers, and crew watch for marine mammals while underway and while setting fishing gear and take action to avoid them. The lack of recent entanglements of threatened and endangered marine mammals, thus far, indicates that the frequency of these types of interactions in fisheries research gear is low. The potential effects from entanglement in research gear is, therefore, considered minor adverse for threatened and endangered species throughout the NWFSC research area during all seasons using gear types similar to those currently in use.

Other Cetaceans

This section describes impacts to cetaceans that are not ESA-listed. Minke whales and gray whales are the only baleen whale species included in this section. The remaining cetaceans are toothed whale species (i.e., odontocetes), including whales, dolphins, and porpoises.

Disturbance and Behavioral Responses due to Acoustic Equipment

The analysis of acoustic effects on these species is similar to that discussed for ESA-listed species above. Table 4.2-15 provides summaries of the numbers of each species that could be taken by Level B acoustic harassment during NWFSC research activities. The likely impact on cetaceans from the different types of acoustic devices is discussed below.

The mid-frequency odontocetes (e.g., pilot whales, killer whales, beaked whales, and dolphins) have a functional hearing range of 150 Hz to 160 kHz, with highest sensitivity from 10-120 kHz. The high-frequency odontocetes (e.g., harbor porpoise and Dall’s porpoise) have a functional hearing range of 200 Hz to 180 kHz, with highest sensitivity from 10-150 kHz. The output frequencies of Category 1 active acoustic sources (>300 kHz) are above the functional hearing range of baleen whales and cetaceans in the mid- and high-frequency hearing groups (Figure 4.2-2). Because they would not be able to hear them, cetaceans are not expected to be affected by Category 1 sound sources (Appendix C, Section 6.2).

Category 2 active acoustic sources are unlikely to be heard by most baleen whales, but are within the range of hearing for various odontocetes, especially high frequency hearing harbor and Dall’s porpoises.

Some of these devices are used on trawl nets during fishing so their use is intermittent, localized and directional, and they are deployed on moving sources. Other Category 2 devices, such as echosounders and current profilers, may be deployed continuously or over long periods during a research cruise. These sound sources are highly directional. The sounds could be loud to cetaceans in close proximity to the sound source but physical damage is unlikely, although TTS could occur if animals remained close to the source (tens to a few hundred meters) for prolonged periods (Appendix C, Section 6.2). Deployment of such devices on moving vessels/gear, their narrow beam widths, and the short duration of most research tows (< 30 minutes) should minimize that likelihood. If detected, short term avoidance is the most likely response (Appendix C, Section 6.2).

There have been no documented cases of marine mammals being disturbed or changing their behavior in response to NWFSC research vessels other than bow-riding by dolphins, which is common with marine vessels and does not appear to have a detrimental effect on the animals. The active sound sources used during fisheries research would not likely be detected by minke whales, although they may be detected by odontocetes, particularly harbor porpoise and Dall's porpoise. The seasonal distribution of both porpoise species throughout the CCRA means they could overlap with fishery research vessels. Sound emission from these active sources is short-term in any localized area. The most likely effect on cetaceans would be localized and temporary avoidance (Appendix C, Section 6.2). Potential disturbance from active acoustic equipment used during research would, therefore, not have any measurable effect on the population of any cetacean and would be considered minor in magnitude. Such disturbance is likely to occur wherever survey vessels use the equipment, but cetaceans would only be close enough to a vessel to be affected on a rare or intermittent basis and any behavioral changes would be temporary. The overall impact of active acoustic sound sources on non ESA-listed cetaceans throughout the NWFSC research area is considered to be minor adverse according to the criteria in Table 4.1-1.

Injury, Serious Injury, or Mortality due to Entanglement in Gear

Table 4.2-14 shows the recent history of marine mammal takes by all NWFSC research activities, including several Pacific white-sided dolphins and two unidentified porpoises or dolphins. All were caught in surface trawls and none survived. Measures to mitigate the risk of entanglements are described in Section 2.2.1.

As described above, the NWFSC LOA application (Appendix C) includes estimates of the potential number of other cetaceans that may interact with research gear based on their similarity to the above species and historical takes in commercial fisheries operating in similar areas and using similar gear types (Table 4.2-16). The LOA application combines estimated Level A harassment takes with serious injury or mortality takes because the degree of injury resulting from gear interaction cannot be predicted. Note that the LOA application does not request authorization to take all species of marine mammals that occur in the NWFSC research area, only those species considered to have a reasonable risk of adverse interactions with gear used for NWFSC research. The LOA application used conservative procedures to estimate potential future takes of marine mammals, so these estimates are greater than what is likely to occur in the future, especially for species that have never been taken in the past and that are infrequently encountered during research surveys.

The NWFSC based the take request for six Pacific white-sided dolphins per year in trawl gear on the worst historical interaction that occurred in 2014 when six dolphins were caught in a single trawl set. Species considered similarly vulnerable to trawl gear as Pacific white-sided dolphins in the CCRA include Risso's dolphin, striped dolphin, and northern right whale dolphin. Using the maximum take of six Pacific white-sided dolphins as a baseline, the NWFSC requests a total of six potential takes (an average of 1.2 animals/year) over the five-year authorization period for each of these species (Table 4.2-16). Based on species previously caught in analogous commercial trawl gear in the CCRA, the NWFSC determined that a total take of one animal each in trawl gear over the 5-year authorization period from the

following species was an appropriate precautionary estimate: harbor porpoise, Dall's porpoise, bottlenose dolphin, short-beaked common dolphin, and long-beaked common dolphin (Table 4.2-16). The NWFSC is not requesting takes of large whales and several other cetaceans by trawl gear due to lack of historical interactions and the low probability of take due to species' distribution, density, abundance, and behavior.

The NWFSC has no history of marine mammal takes in hook-and-line gear or purse seine gear, so any requested takes are based on takes in analogous research, commercial fishing operations, or recreational fisheries. Based on species previously caught in analogous commercial purse seine gear in the CCRA, the NWFSC determined that a total take of one animal each in purse seine gear over the 5-year authorization period from the following species was an appropriate precautionary estimate: harbor porpoise, Dall's porpoise, Pacific white-sided dolphin, Risso's dolphin, short-beaked common dolphin, and northern right whale dolphin (Table 4.2-16). In hook-and-line gear in the CCRA, the NWFSC determined that a total take of one animal each over the 5-year authorization period from the following species was an appropriate precautionary estimate: Risso's dolphin, bottlenose dolphin, striped dolphin, short-beaked common dolphin, long-beaked common dolphin, short-finned pilot whale, and pygmy/dwarf sperm whale (Table 4.2-16). There are several species, such as large whales, that are known to interact with commercial longline fisheries but for which NWFSC is not requesting take. NWFSC research efforts are primarily with rod and reel deployments rather than longlines and the likelihood of interacting with NWFSC longline gear is extremely low considering the low level of survey effort (small numbers of short sets of limited length gear) relative to that of commercial fisheries.

The LOA application includes a request for total takes of one "undetermined dolphin or porpoise species" in trawl gear for the five-year authorization period. This request is made to account for similar looking porpoise and dolphin species that may be caught or entangled in gear, but free themselves or are released before they can be identified or photographed by research personnel. This type of situation would be more likely to occur during the night or other periods of poor visibility.

As described above, the NWFSC has requested takes of some stocks in more than one gear type in the CCRA. The NWFSC also requested takes of marine mammals in various gears in the PSRA and LCRRA (see subsections below). Because the same stock may be taken in multiple gears and several research areas, the analysis of potential effect relative to PBR is made for the combined requested takes from all gears and research areas (Table 4.2-17).

The estimated average annual take in all gears and research areas combined is well below 10 percent of PBR for almost all species (except bottlenose dolphins), even if all annual takes were from a single stock for species with multiple stocks, and less than one percent for several species for which takes are requested (Table 4.2-17). Potential annual takes of Pacific white-sided dolphins would equal about 3.6 percent of PBR, which, although higher than for some species, is still well under 10 percent of PBR (Table 4.2-17). This level of mortality, were it to occur, would be considered minor in magnitude for all stocks except bottlenose dolphins. However, the NWFSC take request also includes an average of 0.2 "undetermined dolphin or porpoise" takes per year in trawl gear. For impact analysis purposes, we must assign these undetermined takes to each stock in addition to those takes requested for the particular stock. Under these assumptions, the combined take request would still be well below 10 percent of PBR for most stocks (Table 4.2-17) and would be considered minor in magnitude.

The exceptions are for the California coastal stock and CA/OR/WA offshore stock of bottlenose dolphin with very small PBR values (Table 4.2-17). For these stocks, the requested take of two animals over the five-year authorization period (0.4 animals per year in all gear types), if it occurred only from animals in one stock, would represent an average of 16.7 percent and 7.3 percent of their respective PBRs. Adding the "undetermined takes" to each stock would increase the percentage of PBR represented to 25.0 percent and 10.9 percent respectively (Table 4.2-17). These levels of take, if they occurred, would be considered moderate in magnitude for these two stocks of bottlenose dolphin according to the criteria described in Table 4.1-1. However, the assumptions of this worst case scenario (all takes occurring in a single stock

and the undetermined dolphin actually being from the same stock in a given year) are highly unlikely to occur given the lack of historical takes for either of these stocks. In addition, the small population sizes of these stocks, the limited scope of NWFSC research efforts within their ranges, and the mitigation measures in place to avoid marine mammal interactions (see Section 2.2.2) further reduce the risk of gear interactions with these stocks. The NWFSC therefore considers the potential effects of NWFSC research on these stocks to be minor.

The potential mortalities represented by the NWFSC take request for these cetacean species would be rare or infrequent events, if they occurred. Any actual take would occur in a localized area, but since cetaceans generally travel through large geographic areas, the potential loss of an animal would affect more than a localized population. The overall impact of the potential takes of these species, if they occurred, would be considered minor adverse according to the criteria described in Table 4.1-1.

Table 4.2-16 Potential Number of Marine Mammal Takes in the NWFSC Research Areas

This table summarizes information presented in the LOA application (Appendix C of the DPEA) on the combined potential takes by Mortality and Serious Injury (M&SI) and Level A harassment over a five-year period using trawls, hook-and-line gears (including longline, rod and reel, and troll deployments), purse seine, and tangle net gear. The LOA application estimates potential takes for the five-year authorization period and these have been averaged for an annual take estimate that can be compared with PBR (Table 4.2-17).

Species	Requested M&SI and Level A Take Average per Year (Total for Five-year Period)										
	CCRA			PSRA		LCRRA		Total: All Areas & Gear			
	Trawl	Purse Seine	Hook-and-Line	Trawl	Hook-and-Line	Trawl	Purse Seine/Tangle Net	Trawl	Hook-and-Line	Purse Seine/Tangle Net	Total Requested Take for Species
Harbor porpoise (several stocks)	0.2 (1)	0.2 (1)	0	0.2 (1)	0	0.2 (1)	0.2 (1)	0.6 (3)	0	0.4 (2)	1 (5)
Dall's porpoise	0.2 (1)	0.2 (1)	0	0.2 (1)	0	0	0	0.4 (2)	0	0.2 (1)	0.6 (3)
Pacific white-sided dolphin	6 (30)	0.2 (1)	0	0	0	0	0	6 (30)	0	0.2 (1)	6.2 (31)
Risso's dolphin	1.2 (6)	0.2 (1)	0.2 (1)	0	0	0	0	1.2 (6)	0.2 (1)	0.2 (1)	1.6 (8)
Bottlenose dolphin (two stocks)	0.2 (1)	0	0.2 (1)	0	0	0	0	0.2 (1)	0.2 (1)	0	0.4 (2)
Striped dolphin	1.2 (6)	0	0.2 (1)	0	0	0	0	1.2 (6)	0.2 (1)	0	1.4 (7)
Short-beaked common dolphin	0.2 (1)	0.2 (1)	0.2 (1)	0	0	0	0	0.2 (1)	0.2 (1)	0.2 (1)	0.6 (3)
Long-beaked common dolphin	0.2 (1)	0	0.2 (1)	0	0	0	0	0.2 (1)	0.2 (1)	0	0.4 (2)
Northern right-whale dolphin	1.2 (6)	0.2 (1)	0	0	0	0	0	1.2 (6)	0	0.2 (1)	1.4 (7)
Short-finned pilot whale	0	0	0.2 (1)	0	0	0	0	0	0.2 (1)	0	0.2 (1)
Pygmy and dwarf sperm whale	0	0	0.2 (1)	0	0	0	0	0	0.2 (1)	0	0.2 (1)

CHAPTER 4 ENVIRONMENTAL EFFECTS
4.2 Direct and Indirect Effects of Alternative 1 – No Action/Status Quo Alternative

Species	Requested M&SI and Level A Take Average per Year (Total for Five-year Period)										
	CCRA			PSRA		LCRRA		Total: All Areas & Gear			
	Trawl	Purse Seine	Hook-and-Line	Trawl	Hook-and-Line	Trawl	Purse Seine/Tangle Net	Trawl	Hook-and-Line	Purse Seine/Tangle Net	Total Requested Take for Species
Undetermined dolphin or porpoise	0.2 (1)	0	0	0	0	0	0	0.2 (1)	0	0	0.2 (1)
California sea lion	1 (5)	0	0.2 (1)	0.2 (1)	0.2 (1)	0.2 (1)	0.2 (1)	1.4 (7)	0.4 (2)	0.2 (1)	2.0 (10)
Steller sea lion (Eastern DPS)	1 (5)	0	0.2 (1)	0.2 (1)	0	0.2 (1)	0.2 (1)	1.4 (7)	0.2 (1)	0.2 (1)	1.8 (9)
Northern fur seal (two stocks)	1 (5)	0	0	0	0	0	0	1 (5)	0	0	1 (5)
Harbor seal	1 (5)	0	0	1 (5)	0.2 (1)	0.2 (1)	0.2 (1)	2.2 (11)	0.2 (1)	0.2 (1)	2.6 (13)
Undetermined pinniped species	0.2 (1)	0	0	0	0	0	0	0.2 (1)	0	0	0.2 (1)

Table 4.2-17 Analysis of Potential Effect on Stocks for which NWFSC is Requesting Take in All NWFSC Research Areas and Gears Relative to PBR.

This table summarizes information on the combined potential takes by Mortality and Serious Injury (M&SI) and Level A harassment in all NWFSC research areas using trawl, hook-and-line, purse seine, and tangle net gear. Hook-and-line gear includes deployment by rod and reel, trolling, and longline gear. All population estimates, Potential Biological Removal (PBR) values, and total annual mortality and serious injury data are from the most recent draft stock assessment reports (Allen and Angliss 2015, Carretta et al. 2015). Note that PBR is an annual measure of mortality. The LOA application estimates potential takes for the five-year period and these have been averaged for an annual take estimate that can be compared with PBR.

Species	Minimum Population Estimate	PBR (Animals Per Year)	Potential M&SI and Level A Take Average per Year – All Research Areas Combined (total for five-year period)			Total (All Areas & Gears Combined)	Total Annual Take Request as % of PBR	Total Annual Take Request with Undetermined Animals	Total Annual Take Request with Undetermined Animals as % of PBR
			Trawl	Hook-and-line	Purse Seine & Tangle Net				
Harbor porpoise (several stocks)	Morro Bay: 2,102 Monterey Bay: 2,480 SF-Russian River: 6,625 N.CA/S.OR: 23,749 N.OR/WA Coast: 15,123 WA Inland Waters: 7,841	Morro Bay: 21 Monterey Bay: 25 SF-Russian River: 66 N.CA/S.OR: 475 N.OR/WA Coast: 151 WA Inland Waters: 63	0.6 (3)	0	0.4 (2)	1 (5)	Morro Bay: 4.8% Monterey Bay: 4.0% SF-Russian River: 1.5% N.CA/S.OR: 0.2% N.OR/WA Coast: 0.7% WA Inland Waters: 1.6%	1.2	Morro Bay: 5.7% Monterey Bay: 4.8% SF-Russian River: 1.8% N.CA/S.OR: 0.3% N.OR/WA Coast: 0.8% WA Inland Waters: 1.9%
Dall's porpoise	32,106	257	0.4 (2)	0	0.2 (1)	0.6 (3)	0.2%	0.8	0.3%
Pacific white-sided dolphin	21,406	171	6 (30)	0	0.2 (1)	6.2 (31)	3.6%	6.4	3.7%
Risso's dolphin	4,913	39	1.2 (6)	0.2 (1)	0.2 (1)	1.6 (8)	4.1%	1.8	4.6%
Bottlenose dolphin (two stocks)	CA Coastal: 290 CA/OR/WA Offshore: 684	CA Coastal: 2.4 CA/OR/WA Offshore: 5.5	0.2 (1)	0.2 (1)	0	0.4 (2)	CA Coastal: 16.7% CA/OR/WA Offshore: 7.3%	0.6	CA Coastal: 25.0% CA/OR/WA Offshore: 10.9%
Striped	8,231	82	1.2 (6)	0.2	0	1.4 (7)	1.7%	1.6	2.0%

Species	Minimum Population Estimate	PBR (Animals Per Year)	Potential M&SI and Level A Take Average per Year – All Research Areas Combined (total for five-year period)			Total (All Areas & Gears Combined)	Total Annual Take Request as % of PBR	Total Annual Take Request with Undetermined Animals	Total Annual Take Request with Undetermined Animals as % of PBR
			Trawl	Hook-and-line	Purse Seine & Tangle Net				
dolphin				(1)					
Short-beaked common dolphin	343,990	3,440	0.2 (1)	0.2 (1)	0.2 (1)	0.6 (3)	<0.1%	0.8	<0.1%
Long-beaked common dolphin	76,224	610	0.2 (1)	0.2 (1)	0	0.4 (2)	0.1%	0.6	0.1%
Northern right-whale dolphin	6,019	48	1.2 (6)	0	0.2 (1)	1.4 (7)	2.9%	1.6	3.3%
Short-finned pilot whale	465	4.6	0	0.2 (1)	0	0.2 (1)	4.3%	NA	NA
Pygmy and dwarf sperm whale	Pygmy: 271 Dwarf: unknown	Pygmy: 2.7 Dwarf: undetermined	0	0.2 (1)	0	0.2 (1)	Pygmy: 7.4%	NA	NA
Undetermined dolphin or porpoise	NA	NA	0.2 (1)	0	0	0.2 (1)	NA	NA	NA
California sea lion	153,337	9,200	1.4 (7)	0.4 (2)	0.2 (1)	2.0 (10)	<0.1%	2.2	<0.1%
Steller sea lion (Eastern DPS)	34,485	1,552	1.4 (7)	0.2 (1)	0.2 (1)	1.8 (9)	0.1%	2.0	0.1%
Northern fur seal (two stocks)	California: 6,722 Eastern Pacific: 541,317	California: 403 Eastern Pacific: 11,638	1 (5)	0	0	1 (5)	California: 0.2% Eastern Pacific: <0.1%	1.2	California: 0.3% Eastern Pacific: <0.1%
Harbor seal ¹	26,667	1,600	2.2	0.2	0.2 (1)	2.6 (13)	0.2%	2.8	0.2%

Species	Minimum Population Estimate	PBR (Animals Per Year)	Potential M&SI and Level A Take Average per Year – All Research Areas Combined (total for five-year period)			Total (All Areas & Gears Combined)	Total Annual Take Request as % of PBR	Total Annual Take Request with Undetermined Animals	Total Annual Take Request with Undetermined Animals as % of PBR
			Trawl	Hook-and-line	Purse Seine & Tangle Net				
			(11)	(1)					
Undetermined pinniped species	NA	NA	0.2 (1)	0	0	0.2 (1)	NA	NA	NA

1. Population estimate and PBR values are for the California stock of harbor seals only. There are no recent population estimates or PBR determinations for the Oregon/Washington Coast, Washington Northern Inland Waters, Southern Puget Sound, or Hood Canal stocks. M & SI data are shown for individual stocks.

Other Pinnipeds

There are five species of non-ESA-listed pinnipeds commonly found in the CCRA that may interact with NWFSC research: California sea lion, Steller sea lion (Eastern DPS), Northern fur seal (two stocks), harbor seal (several stocks), and Northern elephant seal (Table 3.2-4). There are no Level A takes of northern elephant seals anticipated, only Level B acoustic harassment takes (Tables 4.2-15 and 4.2-16).

Disturbance and Behavioral Responses due to Acoustic Equipment

The functional hearing range of seals in the NWFSC operations areas is 75 Hz-100 kHz and, for sea lions and fur seals, it is 100 Hz to 40 kHz. This is well below the output frequency of Category 1 active acoustic sources used by NWFSC, so pinnipeds are unlikely to detect these sounds. Some Category 2 acoustic sources, such as net transponders, are within the hearing range of pinnipeds. The sounds most likely to be audible are of short duration and restricted to areas very close to the research vessel, such as on an active net, so potential interactions are likely to be intermittent and infrequent. Table 4.2-15 provides summaries of the numbers of each species that could be taken by acoustic disturbance during NWFSC research activities. There are no reports or anecdotal observations of pinnipeds being disturbed or altering behavior due to NWFSC fisheries research activities to date. The potential impacts of acoustic disturbance to pinnipeds throughout the NWFSC research area are, therefore, considered to be minor adverse according to the criteria described in Table 4.1-1.

Injury, Serious Injury, or Mortality due to Entanglement in Gear

Table 4.2-14 shows historical takes of pinnipeds by all NWFSC research activities. All takes were in surface trawls and most of those were during the Juvenile Salmon PNW Coastal Survey. There were 16 pinnipeds taken (14 dead, 2 released alive) since 1999, half of which were Steller sea lions. Of these takes, only four have occurred since 2009, two harbor seals and two California sea lions, with one of each species released alive. There have been zero Steller sea lion takes since 2002. Measures to mitigate the risk of entanglements have been developed over the years. Section 2.2.1 describes how mitigation measures were implemented during NWFSC research at the end of 2014.

The NWFSC LOA application (Appendix C of this DPEA) includes calculations of the number of pinnipeds that may interact with research gear based on historical takes, as well as estimates of the potential number of other pinnipeds that may interact with research gear based on their similarity (distributions, life histories, and/or vulnerabilities) to historically taken species, and historical takes in commercial fisheries operating in similar areas and using similar gear types (Table 4.2-16). The NWFSC does not expect this many pinnipeds will actually be taken in the next five years, but is using a conservative estimation procedure to ensure accounting for a precautionary amount of potential take. The NWFSC has also included estimated takes of undetermined pinnipeds to account for the potential that a pinniped could be caught but get free of the gear before it could be identified, as was described above for undetermined dolphins or porpoises.

The potential takes of pinnipeds in trawl gear, as shown in Table 4.2-16, are all based on historical takes during NWFSC fisheries research in the CCRA. The NWFSC does not anticipate takes of northern elephant seals in trawls due to their lower abundance and limited distribution in the CCRA survey areas.

The NWFSC has no history of marine mammal takes in hook-and-line or purse seine gear, although the SWFSC has had interactions with California sea lion in its longline research gear, so any requested takes are based on takes in analogous research or commercial fishing operations. Based on species previously caught in analogous commercial hook-and-line gear in the CCRA, the NWFSC determined that a total take of two California sea lions, one Steller sea lion, and one harbor seal in hook-and-line gear over the 5-year authorization period was an appropriate precautionary estimate (Table 4.2-16). Similarly, the

NWFSC requests potential takes of one California sea lion, one Steller sea lion, and one harbor seal in purse seine gear in the CCRA over the 5-year authorization period (Table 4.2-16).

The NWFSC has requested takes of some pinniped stocks in more than one gear type in the CCRA and also requested takes of pinnipeds in various gears in the PSRA and LCRRA (see subsections below). As described above for cetaceans, because the same stock may be taken in multiple gears and several research areas, the analysis of potential effect relative to PBR is made for the combined requested takes from all gears and research areas (Table 4.2-17).

The estimated average annual take of pinnipeds in all gears and research areas combined, if they occurred, would be much less than one percent of PBR for all stocks and would be considered minor in magnitude (Table 4.2-17). This conclusion would hold true even if the requested “undetermined pinniped” takes are assigned to each stock in addition to those takes requested for the particular stock. Given the low number of pinniped interactions that have occurred in the past and the implementation of current mitigation measures, future mortalities of pinnipeds would likely be rare or infrequent events, if they occurred, and would be unlikely to actually occur at this estimated rate during the 5-year authorization period. Any actual take would occur in a localized area, but these animals travel over large geographic areas so the potential loss of an animal would affect more than a localized population. The overall impact of potential takes of CCRA pinnipeds in NWFSC research gear, if they occurred, would, therefore, be considered minor adverse according to the criteria described in Table 4.1-1.

Sea Otters

There are two subspecies of sea otters in the CCRA. The ESA-listed Southern subspecies is discussed above. The Northern subspecies (Washington stock) is included here. This population inhabits nearshore waters along the outer coast of Washington and the Strait of Juan de Fuca, with occasional sightings of small groups (1-2 individuals) in Puget Sound. Although NWFSC research activities occur along the outer Washington coast, almost all of them occur further offshore in deeper waters than are typically used by sea otters. The NWFSC does not anticipate any future Level B or Level A takes of sea otters from this population based on a lack of historical takes and very little spatial overlap between sea otter habitat and NWFSC research activities under the Status Quo Alternative.

4.2.4.2 Puget Sound Research Area

ESA-listed Species

The endangered marine mammals that occur in the PSRA include the Southern Resident Distinct Population Segment (DPS) of killer whales and occasional (rare) sightings of humpback whales.

Disturbance and Behavioral Responses due to Acoustic Equipment

Active acoustic systems are not used during research in the PSRA so there are no acoustic takes estimated for this research area.

Injury, Serious Injury, or Mortality due to Entanglement in Gear

Table 4.2-14 and Figure 4.2-1 indicate marine mammal takes by all NWFSC research activities from 1999-2014. There have been no takes of threatened or endangered marine mammals in the PSRA by any NWFSC fisheries research activities. The NWFSC is not requesting the take of large whales and several other cetaceans by trawl or purse seine gear due to lack of historical interactions and the low probability of take due to several factors, including density, abundance, distribution, and behavior of these species. The Movement Studies of Puget Sound Species research project uses barbless hook-and-line gear and

employs mitigation measures that include avoiding fishing when killer whales are within 500 meters (Table 2.2.1).

Additional measures to mitigate the risk of entanglements are described in Section 2.2.1. Vessel captains, bridge officers, and crew watch for marine mammals while underway and while setting fishing gear and take action to avoid them. The lack of entanglements of ESA-listed whales indicates that the risk of these types of interactions in fisheries research gear is low. The potential effects from entanglement in research gear is, therefore, considered minor adverse for ESA-listed species throughout the PSRA during all seasons using gear types similar to those currently in use.

Other Cetaceans

This section describes impacts to cetaceans that are not ESA-listed. Minke whales and gray whales are the only baleen whale species included in this section. The other species are toothed whales (odontocetes), including dolphins and porpoises.

Disturbance and Behavioral Responses due to Acoustic Equipment

Active acoustic systems are not used during research in the PSRA so there are no acoustic takes estimated for this research area.

Injury, Serious Injury, or Mortality due to Entanglement in Gear

Table 4.2-14 and Figure 4.2-1 show the recent history of marine mammal takes by all NWFSC research activities. Although Pacific white-sided dolphins, harbor porpoises, and Dall's porpoises occur in the PSRA and surface trawls are used in the Puget Sound Marine Pelagic Food Web and Skagit Bay Juvenile Salmon surveys, no cetaceans have been taken in Puget Sound.

The NWFSC LOA application (Appendix C) includes estimates of the potential number of other cetaceans that may interact with research gear based on their similarity to historically taken species and historical takes in commercial fisheries operating in similar areas and using similar gear types (Table 4.2-16). The LOA application only requests takes of species considered to have a reasonable risk of adverse interactions with gear used for NWFSC research. Thus the NWFSC is not requesting Level A harassment (injury) or mortality/serious injury takes of any cetaceans during hook-and-line research surveys in the PSRA. Based on takes of marine mammals in analogous commercial fisheries, the NWFSC determined that a total take of one harbor porpoise and one Dall's porpoise in trawl gear over the 5-year authorization period was an appropriate precautionary estimate (Table 4.2-16).

The estimated average annual take of these two stocks in all gears and research areas combined, if they occurred, would be less than two percent of PBR for the Washington Inland Waters stock of harbor porpoise and less than one percent of PBR for Dall's porpoise and would be considered minor in magnitude (Table 4.2-17). The overall impact of the potential takes of these species in the PSRA would, therefore, be considered minor adverse according to the criteria described in Table 4.1-1.

Other Pinnipeds

There are three species of non-ESA-listed pinnipeds commonly found in the PSRA that may interact with NWFSC research: California sea lion, Steller sea lion (Eastern DPS), and harbor seal (Table 4.2-17).

Disturbance and Behavioral Responses due to Acoustic Equipment and Physical Presence of Researchers

Active acoustic systems are not used during research in the PSRA so there are no acoustic takes estimated for this research area. However, there are numerous pinniped haulouts in Puget Sound and these animals may be disturbed by the physical presence and sounds of researchers passing nearby in small boats as they travel to research sites. NWFSC researchers in the PSRA are very aware of this situation and take

precautions to minimize the frequency and scope of potential disturbances, including choosing travel routes as far away from hauled out pinnipeds as possible and moving sample site locations to avoid consistent haulout areas. However, there are many narrow channels among the islands of Puget Sound where the options for vessel traffic are limited. Combined with the fact that pinnipeds may haul out in new locations on a regular basis, it is essentially impossible for researchers to completely avoid disturbing pinnipeds as they travel around. Table 4.2-18 provides estimated numbers of seals and sea lions that may be exposed to Level B harassment disturbance due to the presence of NWFSC researchers in the PSRA based on past experiences under status quo conditions.

Based on the locations of known haulouts (Jeffries et al. 2000) and the frequency of past research efforts passing those haulouts, the NWFSC estimates that about 1,440 harbor seals and 350 California sea lions on haulouts may be passed by NWFSC research vessels an average of eight times per year in the PSRA (Table 4.2-17). It is likely that many of these animals are not disturbed as research vessels pass but NWFSC fisheries researchers have not recorded numbers of animals actually affected by their presence. Until more accurate data becomes available through the proposed new monitoring and reporting program outlined in the LOA application (i.e., in the Preferred Alternative), it is assumed that 100 percent of these animals may react to NWFSC research activity. This pre-cautionary approach accounts for the possible (albeit unlikely) event that all animals react to each vessel pass. Therefore, the estimated annual Level B Harassment takes for the PSRA is 11,520 harbor seals and 2,800 California sea lions. The NWFSC recognizes these estimated take levels are likely large over-estimates and that actual taking by harassment will be considerably smaller. This level of periodic, infrequent, and temporary disturbance is unlikely to affect the use of the region by any of these species.

Table 4.2-18 Estimated Level B Harassment Takes of Pinnipeds due to the Physical Presence of Researchers in the PSRA

Species	Estimated Number of Pinnipeds on Haulouts Passed by Survey Vessels	Average Number of Passes per Year	Potential Level B Harassment Take Average per Year
PUGET SOUND RESEARCH AREA			
Harbor seals	1440	8	11,520
California sea lion	350	8	2,800
LOWER COLOMBIA RIVER RESEARCH AREA			
Harbor seals	3000	25	75,000

Injury, Serious Injury, or Mortality due to Entanglement in Gear

Table 4.2-14 and Figure 4.2-1 show historical takes of pinnipeds by all NWFSC research activities. All takes were in surface trawls. The only take in the PSRA was of a single harbor seal in 2009 during the Skagit Bay Juvenile Salmon Survey. Upon noting harbor seal activity adjacent to the net, trawling was stopped, the net retrieved, and the seal was released alive. Measures to mitigate the risk of entanglements are described in Section 2.2.1.

The NWFSC LOA application (Appendix C) includes calculations of the number of pinnipeds that may reasonably be expected to interact with research gear based on historical takes, as well as estimates of the potential number of other pinnipeds that may interact with research gear based on their similarity

(distributions, life histories, and/or vulnerabilities) to historically taken species and historical takes in commercial fisheries operating in similar areas and using similar gear types (Table 4.2-16). Based on one historical take in research gear in the PSRA, the NWFSC is requesting five harbor seal takes in trawl gear over the 5-year authorization period. The NWFSC does not consider any other species of pinniped to be vulnerable to trawl gear in the PSRA. However, based on analogous commercial and recreational fisheries with hook-and-line gear in the PSRA, the NWFSC is requesting takes of one California sea lion and one harbor seal in hook-and-line gear over the 5-year authorization period (Table 4.2-16).

The estimated average annual take of these pinniped stocks in all gears and research areas combined, if they occurred, would be much less than one percent of PBR and would be considered minor in magnitude (Table 4.2-17). The overall impact of the potential takes of these species in the PSRA would, therefore, be considered minor adverse according to the criteria described in Table 4.1-1.

Sea Otters

The Northern subspecies (Washington stock) of sea otters occurs in the PSRA. This population inhabits nearshore waters along the outer coast of Washington and the Strait of Juan de Fuca, with occasional sightings of small groups (1-2 individuals) in Puget Sound. Although the Strait of Juan de Fuca and Puget Sound are within the PSRA, the NWFSC does not anticipate any future Level B or Level A takes of sea otters from this population based on a lack of historical takes and very little spatial overlap between sea otter habitat and NWFSC research activities in this area under the Status Quo Alternative.

4.2.4.3 Lower Columbia River Research Area

ESA-listed Species

The endangered marine mammals that occur in the LCRRA include occasional sightings of Southern resident killer whales at the mouth of the Columbia River. The Eastern DPS of Steller sea lions, previously listed as threatened, was recently removed from the List of Threatened and Endangered Species (November 2013) and is now included below under Other Pinnipeds.

Disturbance and Behavioral Responses due to Acoustic Equipment

Active acoustic systems are not used during research in the LCRRA so there are no acoustic takes estimated for this research area.

Injury, Serious Injury, or Mortality due to Entanglement in Gear

There have been no historical takes of ESA-listed marine mammals in the LCRRA and the NWFSC is not anticipating any future takes of ESA-listed species in the LCRRA because the risk of interactions with fisheries research gear used in the LCRRA is very low. The potential effects from entanglement in research gear is, therefore, considered minor adverse for ESA-listed species throughout the LCRRA during all seasons using gear types similar to those currently in use.

Other Cetaceans

There are no non-ESA-listed cetaceans that occur with any regularity in the LCRRA and none have been taken historically during NWFSC fisheries research. However, harbor porpoise occasionally enter the mouth of the river and based on their vulnerability to commercial trawl fisheries in other areas as well as a limited amount of research trawling in that area, the NWFSC LOA application (Appendix C) includes an estimated take of one animal from this species in trawl gear over the 5-year authorization period (Table 4.2-16). For similar reasons, the NWFSC estimates one take of harbor porpoise in purse seine or tangle net gear in the LCRRA over the 5-year authorization period. There is no commercial fishing gear equivalent to tangle nets but the NWFSC considers them to be similar in risk of capturing or entangling

dolphins and porpoises as purse seine gear. The estimated average annual take of harbor porpoise in all gears and research areas combined, if they occurred, would be less than 10 percent of PBR for all stocks (Table 4.2-17) and would be considered minor adverse according to the criteria described in Table 4.1-1.

Other Pinnipeds

There are three species of non-ESA-listed pinnipeds commonly found in the LCRRA that may interact with NWFSC research: California sea lion, Steller sea lion (Eastern DPS), and harbor seal.

Disturbance and Behavioral Responses due to Acoustic Equipment and Physical Presence of Researchers

Active acoustic systems are not used during research in the LCRRA so there are no acoustic takes estimated for this research area. In the LCRRA, the only species encountered on haulouts is harbor seals. The NWFSC estimates that 3,000 harbor seals may be present on haulouts that are passed by NWFSC research vessels an average of 25 times per year. The estimated annual Level B Harassment takes is therefore about 75,000 for harbor seals in the LCRRA (Table 4.2-17). The NWFSC recognizes these estimated take levels are likely large over-estimates and that actual taking by harassment will be considerably smaller. This level of periodic, infrequent, and temporary disturbance is unlikely to affect the use of the region by harbor seals.

Disturbance and Behavioral Responses due to Active Deterrence of “Nuisance Animals”

Visual and acoustic deterrence devices and techniques are occasionally used to dissuade pinnipeds attempting to enter or remove fish from research gear during the Pair Trawl Columbia River Juvenile Salmon Survey and the Migratory Behavior of Adult Salmon Survey in the LCRRA. Pinnipeds attempting to catch fish inside research gear are considered “nuisance animals” and the humane, non-lethal removal of such animals by government employees (i.e., NWFSC researchers) acting in the course of official duties is exempted under Section 109(h) of the MMPA (16 USC 1379).

Approaching nuisance animals with the tender skiff will often suffice to dissuade closer approaches to the gear. Aerial pyrotechnics (poppers and screamers) are the next line of defense against persistent seals and sea lions, followed by underwater detonation of seal bombs as a last resort deterrence technique. Typically, the nuisance animal will temporarily move a short distance away, but will rarely leave the area. An average of 26 seal bombs have been used to deter sea lions from pair trawls in recent years. Aerial pyrotechnics (poppers and screamers) were used approximately 15 to 20 days each year, with a maximum of 50 used per day, to deter pinnipeds from tangle nets in recent years. These deterrence techniques are directed at individual nuisance pinnipeds (primarily California sea lions) that exhibit short-term and short-distance displacement from the area; long-term or population-level effects are unlikely. Potential effects of active deterrence on pinnipeds during NWFSC research activities in the LCRRA would, therefore, be considered minor adverse according to the criteria described in Table 4.1-1.

Injury, Serious Injury, or Mortality due to Entanglement in Gear

There have been no historical takes of marine mammals in the LCRRA. However, based on analogous takes in commercial and recreational fisheries operating in similar areas and using similar gear types, the NWFSC estimates the potential to take one animal each of California sea lion, Steller sea lion, and harbor seal in trawl gear and one each of each species in purse seine/tangle net gear over the 5-year authorization period (Table 4.2-16). The estimated average annual take of these species in all gears and research areas combined, if they occurred, would be well below ten percent of known or potential PBR for each of these species (Table 4.2-17). This level of mortality would be considered minor in magnitude for all species. Potential effects of NWFSC research activities on pinnipeds in the LCRRA would, therefore, be considered minor adverse according to the criteria described in Table 4.1-1.

4.2.4.4 Conclusion

Potential direct and indirect effects of NWFSC research activities on marine mammals have been considered for all gear used in research under the Status Quo Alternative. Given the very small amounts of fish and invertebrates removed from the ecosystem during scientific sampling, the dispersal of those sampling efforts over large geographic areas, and the short duration of sampling efforts, the overall risk of causing changes in food availability for marine mammals is considered minor adverse. Also, given the crew training, required emergency equipment, and adherence to environmental safety protocols on NOAA research vessels and NOAA chartered vessels, the risk of altering marine mammal habitat through contamination from accidental discharges into the marine environment is considered minor adverse.

All species may be exposed to sounds from active acoustic equipment used in NWFSC research in the CCRA, although several acoustic sources are not likely audible to many species. Those that are audible would likely cause temporary and minor changes in behavior for nearby animals as the ships pass through a given area. The potential for temporary threshold shifts in hearing is low for high frequency cetaceans (harbor and Dall's porpoises) and very low to zero for other species, particularly low frequency cetaceans. The potential for hearing loss or injury to any marine mammal is essentially zero. Because of the minor magnitude of effects and temporary duration of acoustic disturbance, the overall effects of acoustic disturbance are considered minor adverse for all species throughout the NWFSC research area.

At least one cetacean species (Pacific white-sided dolphins plus unidentified porpoises or dolphins) and four pinniped species (harbor seal, California sea lion, Steller sea lion, and northern fur seal) have been caught in NWFSC research gear since 1999. These historic data and other data on mortalities in commercial fisheries using similar gear were used to estimate potential takes (combined Level A harassment and serious injury and mortality) in the next five years under status quo conditions, which include a suite of mitigation measures implemented for NWFSC surveys. Future takes, if they occur, would likely be fewer than the estimates since they are based on a conservative approach to ensure accounting for a precautionary level of potential take. The estimated annual potential takes for most species are less than 10 percent of PBR and would be considered to have minor magnitudes of effect at the population level. The estimated annual potential take of two bottlenose dolphin stocks, including "undetermined dolphin or porpoise" takes, would be between 10 and 50 percent of PBR and would be considered to have moderate magnitudes of effect, although that level of take for these stocks is considered very unlikely. Adverse interactions with research gear would likely continue to occur rarely but could occur anywhere the NWFSC conducts fisheries research; impacts would likely be dispersed over time and space. The overall impact of the potential takes of these species, if they occurred, would be considered minor adverse according to the criteria described in Table 4.1-1.

The overall effects of the Status Quo Alternative on marine mammals would be minor in magnitude, dispersed over a large geographic area, and temporary or short-term in duration, and would therefore be considered minor adverse according to the impact criteria in Table 4.1-1.

4.2.5 Effects on Birds

This section describes the effects of the status quo NWFSC research activities on seabirds. The potential effects of research vessels, survey gear, and other associated equipment on seabirds include:

- Injury or mortality due to ship strikes and entanglement in gear
- Changes in food availability due to survey removal of prey and discards
- Contamination or degradation of habitat

Injury and Mortality Due to Ship Strikes and Entanglement in Fishing Gear

There are several potential mechanisms for NWFSC research activities to cause injury or mortality to seabirds. Many seabirds are attracted to fishing vessels in order to forage on bait, offal, discards, and natural prey disturbed by the fishing operation. This attraction to fishing vessels increases the chance for birds to inadvertently collide with cables or lines and other structures on the vessel as well as being caught in the fishing gear. Bird strikes are probably most numerous during the night and during storms or foggy conditions when bright deck lights are on, which can cause the birds to become disoriented (NMFS 2004). Such collisions with gear or vessels are hard to detect, especially without a dedicated research effort to monitor bird interactions.

In some parts of the world, mortality of seabirds in commercial fishing gear, especially longlines and gillnets, is a major conservation concern for albatross, gulls, and other species that follow commercial fishing vessels. Diving birds are vulnerable to getting caught in gill nets and other fishing gear near the surface as it is being set or hauled in. In the CCRA, commercial fisheries using set and drift gillnets and longline gear have the worst records of taking seabirds, and a number of species are considered to have population-level effects as a result (Mills et al. 2005).

Changes in Food Availability

Fishing activities can have potentially adverse effects on seabirds through changing the abundance or distribution of their prey species. A recent study (Cury et al. 2011) examined data from the past 45 years and all of the world's oceans and found that when prey abundance (small fish and invertebrates) dropped below one third of maximum documented biomass, seabird reproductive success declined significantly. This held true for species all over the world. Many factors influence the abundance and distribution of seabird prey, including strong roles for oceanographic and weather fluctuations, but commercial fisheries are also a factor. Although it is very difficult to demonstrate the indirect effects of fishing for other species and size classes on the availability of prey for seabirds, directed fishing on small schooling fish (e.g. sardines and anchovies) and invertebrates (e.g. krill) have played major roles in driving seabird prey populations below the "one third limit" in many areas (Cury et al. 2011).

Fishing activities may also have beneficial effects on seabirds by providing offal and discards that would otherwise be unavailable to birds. In some areas with intensive fishing efforts, offal may constitute a substantial portion of the total food consumed by scavenging species such as gulls (Tasker and Furness 1996). However, while scavenging may benefit individual birds, it also places them in danger from entanglement and incidental take in fishing gear.

The short duration of fisheries research tows, the dispersal of research effort over wide areas of sea, and the relatively small number of research surveys over time makes it very unlikely that the abundance or distribution of seabird prey would be affected by research activities in any of the three NWFSC research areas. This is especially true for the small size classes of fish and pelagic invertebrates favored by most seabirds because of their large biomasses and the minimal amounts taken in research samples (Sections 4.2.3 and 4.2.7). For the same reasons, the amount of food made available through research activities is unlikely to have more than temporary and highly localized beneficial effects on seabirds.

Contamination or Degradation of Habitat

Contamination from spills and discharges can accumulate in the seafloor and marine life and have a toxic effect on the plants, animals and humans through the food chain (NOAA 2010c). While there are no intentional discharges of pollutants from NWFSC or any other fisheries research vessels, there is the potential for accidental spills to occur. Discharge from vessels, whether accidental or intentional, may include sewage, ballast water, fuel, oil, miscellaneous chemicals, garbage, and plastics.

All NOAA and ocean going vessels are subject to the regulations of MARPOL 73/78, the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 (NOAA 2010b). MARPOL includes six annexes that cover discharge of oil, noxious liquid substances, harmful packaged substances, sewage, garbage, and air pollution (IMO 2010). Adherence to these regulations minimizes or negates the likelihood of discharges of potentially harmful substances into the marine environment. Annex V specifically prohibits plastic disposal anywhere at sea and severely restricts discharge of other garbage (IMO 2010).

NOAA vessels are operated by the NOAA Commissioned Officer Corps, one of the seven uniformed services of the United States. All NOAA vessels are fully equipped to respond to emergencies, including fuel spills, and crew receive extensive safety and emergency response training. These precautionary measures help reduce the likelihood of fuel spills occurring, and increase the chance that they will be responded to and contained quickly. Oil spill prevention training and equipment may be more variable on commercial fishing vessels that are chartered for research purposes, but all vessels are required to comply with USCG regulations on spills. Discharge of contaminants from vessels used during research surveys is possible, but unlikely, and if it occurs, would be isolated in both time and location, and likely small in volume. This conclusion applies to all three NWFSC research areas.

4.2.5.1 California Current Research Area

Seabirds occur throughout the year in all areas of the CCRA concurrent with NWFSC research activities. Fisheries research surveys use several gear types that have been demonstrated to result in seabird mortality in commercial fisheries of the Pacific, including longlines and pelagic trawls (Mills et al. 2005). On NOAA vessels or chartered vessels, any seabird takes during survey efforts are recorded. From 2002 through 2014 a total of 20 seabirds of five species have been killed during NWFSC research activities in the CCRA, all during the Juvenile Salmon PNW Coastal Survey using a Nordic 264 surface trawl. The takes consisted of 14 common murrelets, 2 tufted puffins, 2 rhinoceros auklets, and 1 each of Cassin's auklet and sooty shearwater, for an average of 1.67 birds per year. Figure 4.2-3 shows the locations of the takes, which were dispersed over a large area. Under the Status Quo Alternative, the Juvenile Salmon PNW Coastal Survey would continue to be conducted at the same level of effort as the past surveys and a similar number of seabird takes would be expected to occur in the future. The estimated number of takes is small compared to the populations of these species so the magnitude of mortality in research gear is therefore considered minor for all species.

The lack of seabird mortalities during NWFSC fisheries research using other gear types may be due in part to the short tow/set times for research surveys relative to typical commercial fishing efforts, and also to the much smaller number of vessels and gear sets involved in research. As stated earlier, it is usually very difficult to detect seabird collisions with gear or vessels but there are no records of any bird mortalities due to ship strikes during NWFSC conducted fisheries research activities. There is still a potential for mortality to occur from gear entanglement or ship strikes but they are likely to be rare events that would not affect seabird populations.

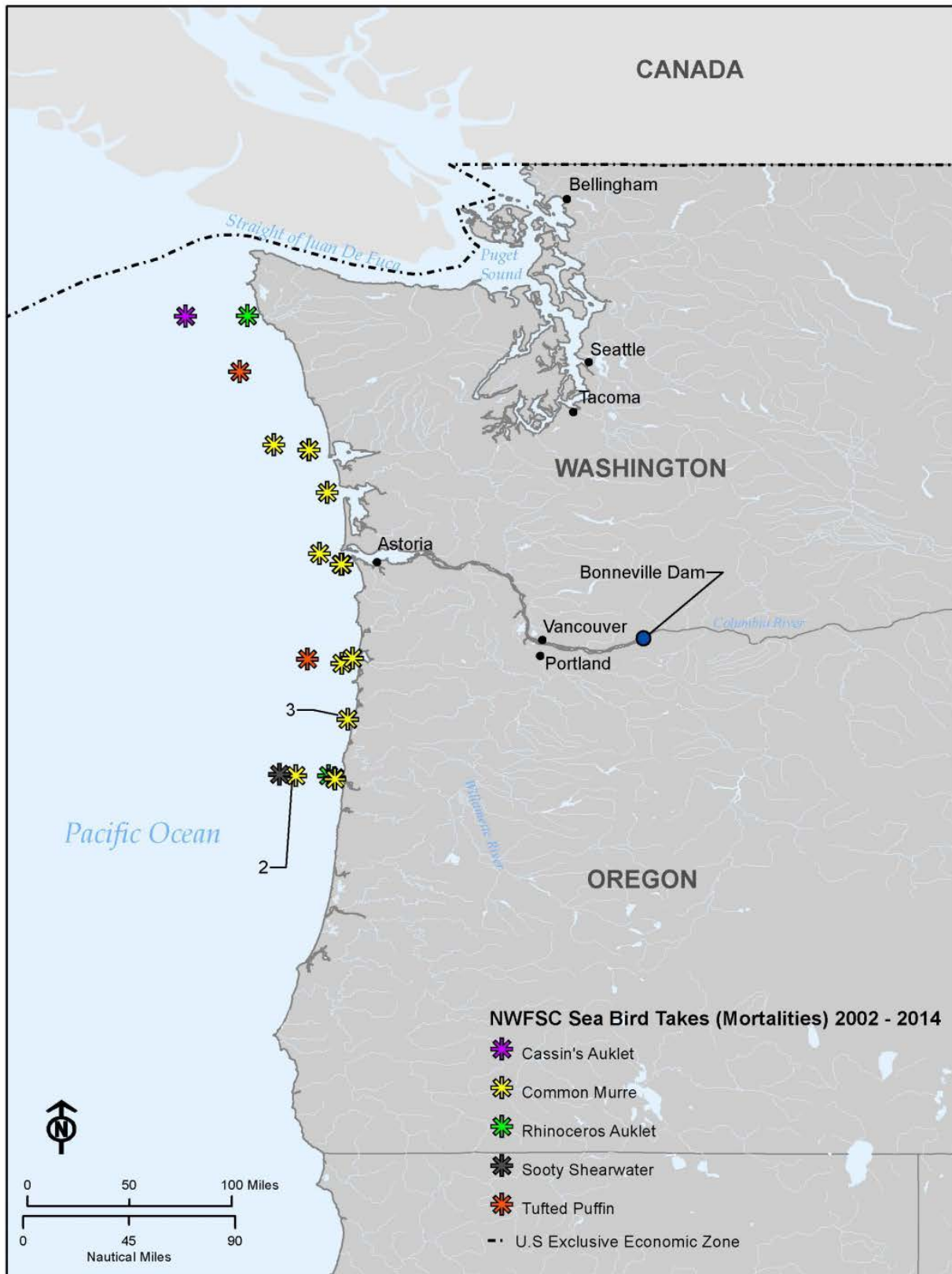


Figure 4.2-3 Locations of Seabird Takes during NWFSC Research from 2002 through 2014

4.2.5.2 Puget Sound Research Area

Seabirds occur throughout the year in all areas of the PSRA concurrent with NWFSC research activities. However, the NWFSC research activities in the PSRA have no history of taking seabirds. The gear types that have been used in these surveys (purse seines, small plankton nets, fyke traps, and beach seines) have not been implicated in seabird takes in commercial fisheries as have trawls, longline, and gill nets. The NWFSC research protocols provide little or no offal and no bait to attract birds. The risk of injury or mortality is therefore very small and future impacts on seabirds in the PSRA would likely be rare under the Status Quo Alternative.

4.2.5.3 Lower Columbia River Research Area

Seabirds occur throughout the year in all areas of the LCRRA concurrent with NWFSC research activities. However, the NWFSC research activities in the LCRRA have no history of taking seabirds. The gear types that have been used in these surveys (purse seines, beach seines, tangle nets, and trap nets) have not been implicated in seabird takes in commercial fisheries as have trawls, longline, and gill nets. The NWFSC research protocols provide little or no offal and no bait to attract birds. The risk of injury or mortality is therefore very small and future impacts on seabirds in the LCRRA would likely be rare under the Status Quo Alternative.

4.2.5.4 Conclusion

The effects of NWFSC fisheries research on seabirds include the potential for injury and mortality in fishing gear and ship strikes, changes in food availability, and contamination or degradation of habitat. Incidental captures of seabirds in NWFSC research gear have occurred infrequently in the CCRA but not in the PSRA or LCRRA and the magnitude of these takes are considered minor under the Status Quo Alternative. The overall risk of NWFSC fisheries research causing changes in food availability for seabirds or contamination in the marine environment detrimental to seabirds is considered minor adverse.

The overall effects on seabirds from NWFSC research activities under the Status Quo Alternative would likely be minor in magnitude, dispersed over a large geographic area, and temporary or short-term in duration and would therefore be considered minor adverse according to the criteria in Table 4.1-1. This conclusion holds for each of the three NWFSC research areas and for all gear types used in research.

4.2.6 Effects on Sea Turtles

This section describes the types of effects of the Status Quo Alternative on five different species of ESA-listed sea turtles: leatherback, olive ridley, green, loggerhead, and hawksbill sea turtles. In North Pacific waters, leatherback and hawksbill sea turtles are listed as endangered while the other three species of sea turtles are listed as threatened under the federal ESA. Direct and indirect effects of NWFSC research activities on sea turtles may include:

- Disturbances and changes in sea turtle behavior due to physical movements and sounds
- Injury or mortality due to ship strikes and entanglement in gear
- Injury or mortality due to interactions with fishing gear
- Changes in food availability due to survey removal of prey
- Contamination or degradation of sea turtle habitat

While sea turtles may infrequently occur near the entrances to the PSRA and LCRRA, most of the potential effects of NWFSC research on sea turtle would occur in the CCRA. Although the NWFSC has no history of interactions with sea turtles in research gear, some of the mitigation measures implemented

to reduce interactions with marine mammals may function to reduce the potential for adverse interactions with sea turtles, and are described in Section 2.2.

Disturbance and Changes in Behavior Due to Physical Movements and Sound Sources

There is a potential for research activities to negatively affect or disturb sea turtles and cause changes in behavior, primarily through the physical presence of marine vessels and fishing gear, operational sounds from engines and hydraulic equipment, and active acoustic devices used for navigation and research.

Little is known about hearing in sea turtles, but the available information suggests that their underwater hearing capabilities are quite limited both in functional hearing bandwidth and in absolute hearing sensitivity. The limited data suggest that sea turtles probably have functional hearing sensitivity between about 100 Hz and 1.2 kHz (Ketten and Bartol 2005, Dow Piniak et al. 2012), which is well below the frequencies of acoustic instruments used in fisheries research. The higher frequency sounds are unlikely to be audible to sea turtles and therefore unlikely to have adverse effects on sea turtles.

Sea turtles may be disturbed or displaced from their normal behavior or movements by passing vessels or fishing gear in the water. Given the small number of NWFSC research vessels and their dispersal over a wide area, behavioral disturbances resulting from NWFSC research activities would be temporary in nature, lasting only a few minutes as the research vessel passes, and are therefore likely to have no more than negligible effects on turtle foraging success or survival.

Injury or Mortality Due to Ship Strikes

The two main mechanisms for research activities to cause injury or mortality to sea turtles are ship strikes and entanglement in fishing gear. Sea turtles come to the surface to breathe, and also to rest, making them susceptible to ship strikes. Because it is often difficult for vessels underway to see turtles, there is little data available on the frequency of ship strikes on sea turtles. Bridge crew on NWFSC research cruises routinely watch for floating obstacles while underway and would take measures to avoid collisions with sea turtles if they could. There have been no reported incidents of ship strikes by NWFSC research vessels or by cooperative research vessels, although there is the possibility that such strikes have occurred without notice by the crew.

Transit speeds on NWFSC research cruises vary from 6-14 knots, but average 10 knots. The vessel's speed during active sampling is typically 2-4 knots due to sampling design, and these slower speeds are assumed to minimize the risk of collisions with sea turtles. Given the relatively slow speeds of research vessels, the presence of dedicated watches during survey activities, and the small number of research cruises, collisions with sea turtles resulting from the research activities conducted under the Status Quo Alternative are considered very unlikely.

Injury or Mortality Due to Interactions with Fishing Gear

There are many factors that may contribute to the likelihood of sea turtles interacting with fishing gear, including capture or entanglement in various nets, collisions with mobile gear, and getting hooked by longline gear. Some of the variables involve details of the fishing gear such as the type and size of hooks and the bait used for longline surveys. Other variables involve the distribution and abundance of sea turtles in the area which may be related to the presence of prey sources, seasonal migration patterns, and oceanographic features. Sea turtles migrate toward southern waters for the winter so the overlap of NWFSC fisheries research and sea turtles is not uniform over time and space. The primary risk of interactions with sea turtles is for NWFSC research activities that occur in non-winter months in the southern parts of the CCRA. However, there are no recorded incidents of sea turtle interactions with any NWFSC research gear.

One of the most important factors determining the likelihood of mortality for turtles caught in fishing gear is the length of time they are held underwater (Henwood and Stuntz 1987, Epperly et al. 2002, Sasso and Epperly 2006). According to a study conducted by the National Research Council, “death rates [of sea turtles incidentally captured in trawls] are near zero until tow times exceed 60 minutes, then they rise rapidly with increasing tow times to around 50 percent for tow times in excess of 200 minutes” (NRC 1990). While long tow times are common in commercial fisheries, all of the NWFSC fisheries research surveys using trawl gear have protocols with tow times less than 30 minutes long (Table 2.2-1). The NWFSC has not caught sea turtles in research trawls in the past so the chances of future takes are small and any future captures, if they occurred, would likely be released alive.

Changes in Food Availability Due to Survey Removal of Prey

Western Pacific leatherback turtles forage seasonally on dense aggregations of jellyfish off the West Coast of the United States (Graham 2009). All life stages consume gelatinous organisms such as jellyfish and tunicates (Eckhert et al. 2012). Several species of jellyfish, including the two common large jellyfish species, *Chrysaora fuscescens* and *Aurelia labiata*, are frequently caught as a result of NWFSC fisheries research activities in the CCRA. Regurgitated stomach contents and observations of actively foraging individuals in the study area indicate *Chrysaora fuscescens* is more frequently consumed by leatherbacks than other scyphozoan species (Graham 2009).

The average annual catch of *Chrysaora fuscescens* from NWFSC research surveys from 2008-2012 is about 1,987 kg, and the estimated total average annual catch of *Aurelia* species is 1,265 kg (Table 4.2-19). Catches of jellyfish from the Groundfish Bottom Trawl Survey far exceed those from other NWFSC surveys. Although the total biomass of jellyfish species in NWFSC research areas is difficult to estimate, a mean areal density of $251,522 \pm 57,504$ jellyfish per square nautical mile has been calculated in the central California foraging area of leatherback turtles based on acoustic backscatter survey data (Graham 2009). Thus, due to the extremely high densities of jellyfish encountered in leatherback foraging areas, the amount of jellyfish removed as a result of NWFSC surveys would have no measurable effects on the availability of jellyfish as a food source or the quality of critical habitat for leatherback sea turtles.

Contamination or Degradation of Habitat

Bottom trawls and other bottom-contact gear can disrupt the ocean floor and benthic sediment. This can disturb or damage important foraging habitats for sea turtles, and cause turbidity in the water that could make it difficult for turtles to locate prey. However, surveys conducted by NWFSC research programs impact very small areas of the ocean floor relative to the entire area and relative to the footprint of commercial fisheries (see Section 4.2.2), and, due to the stratified random design of many surveys, typically do not occur in the same geographic location from year to year. The impacts of research gear on benthic habitat, including the critical habitat for leatherback sea turtles, are therefore small in magnitude and temporary in duration.

For the same reasons described for fish (Section 4.2.3) and marine mammals (Section 4.2.4), potential effects on sea turtles from accidental discharges of fuel or other contaminants from NWFSC research vessels are possible but unlikely to occur in the near future. If an accidental discharge does occur, it is likely to be a rare event and the potential volume of material is likely to be small and localized. The potential impacts to sea turtles would be similarly short-term, localized, and likely affect a small number of animals. The overall impact of accidental contamination of sea turtle habitat would therefore be considered minor adverse.

4.2.6.1 Conclusion

NWFSC fisheries research activities conducted under the Status Quo Alternative involve a relatively small number of research vessels, short deployments of fishing gear, and sample sites dispersed over a

wide area. Behavioral disturbances of sea turtles from research vessels or fishing gear would be temporary in nature, lasting only a few minutes as the research vessel passes, and are therefore likely to have negligible effects on turtle foraging success or survival. There have been no gear interactions with sea turtles and NWFSC research activities in the past so the potential for injury or mortality under the Status Quo Alternative is very small. The potential for research vessels to degrade turtle habitat through benthic disturbance, changes in prey availability, or contamination from accidental spills and discharges would likely be minor in magnitude, infrequent or rare, and localized.

The overall effects of the Status Quo Alternative on ESA-listed sea turtles, and critical habitat for leatherback turtles, would likely be small in magnitude, dispersed over a large geographic area, and temporary or short-term in duration and would therefore be considered minor adverse on all species of sea turtles according to the criteria in Table 4.1-1.

4.2.7 Effects on Invertebrates

This section describes the potential effects of NWFSC research activities on invertebrates under the Status Quo Alternative. The potential effects of research vessels, survey gear, and other associated equipment on invertebrates would include:

- Mortality from fisheries research activities
- Physical damage to infauna and epifauna
- Changes in species composition
- Contamination or degradation of habitat

Two invertebrate species found within the CCRA are listed as endangered under the ESA, black abalone and white abalone. Neither species has been caught in NWFSC affiliated research in the past and is unlikely to be caught in the future. The potential effects of the Status Quo Alternative on these species are therefore negligible and they will not be discussed further.

Mortality from Fisheries Research Activities

The NWFSC uses various research methods and gear to sample invertebrates, including bottom trawls, pelagic trawls, and a variety of plankton nets (see Table 2.2-1 and Appendix A for descriptions of the equipment used for each survey). Most of the invertebrate catch in NWFSC research occurs in the CCRA and the majority is caught during the Groundfish Bottom Trawl Survey. Bycatch Reduction Research has caught substantial amounts of pink shrimp while testing different configurations of commercial shrimp trawl gear and the Hake Acoustic Survey has caught substantial amounts of Humboldt squid in pelagic trawls. In addition, benthic invertebrates can be crushed by fishing gear that contacts the sea floor, such as bottom trawls. There is decreased crush injury to invertebrates in locations where the substrate consists of sand, silt and/or mud (Hiddink et al. 2006). Acoustic survey equipment and underwater photo platforms, including drop cameras and ROVs, are also used to survey benthic habitats, minimizing impacts to invertebrates.

The impact of mortality from fisheries research depends on the magnitude of the research catch relative to the overall biomass or population level of the species. Measuring these relative effects is difficult because there are very few invertebrate species for which total populations have been estimated with any degree of certainty and only commercially important species may be monitored for population trends. For a few species that are caught and monitored regularly in commercial fisheries, this DPEA compares the amount of invertebrates caught in NWFSC research to the amount caught in commercial fisheries as a metric for the magnitude of research catch. Because commercial harvest limits are set at a fraction of estimated population, the magnitude of research catches relative to overall population levels would be much less than what is indicated by the comparisons with commercial landings. This DPEA does not attempt to

analyze the effects of research mortality on each of the invertebrate species caught in the various surveys, only those species with average annual catch exceeding one metric ton (1000 kgs) from all research activities combined. Table 4.2-18 shows the average annual catch of invertebrate species during a recent five year period (2008-2012) to represent the level of catch under the Status Quo Alternative. These average annual research catches are compared to the average annual commercial landings from 2008-2012 for all species where such information is available.

In the CCRA, average research catch was well below one percent of commercial landings for two commercially harvested invertebrate species and less than two percent for another species. For these species, the magnitude of research mortality is very small relative to the commercial fisheries and even smaller relative to the estimated populations of these invertebrates. For other species, population metrics are not available but the NWFSC believes research catches are very small and unlikely to have measurable effects on any population of invertebrates.

In the PSRA, NWFSC research catch of invertebrates primarily involves sampling plankton, juvenile fish, and small pelagic invertebrates using various small fine-mesh nets. The Movement Studies of Puget Sound Species study has caught small numbers of invertebrates (a few hundred to a couple thousand individuals) of squat lobster, spot prawn, pink shrimp, sidestripe shrimp and sunflower stars. There are no data on the weight of invertebrates killed in the PSRA because most are released alive after counting but it would be minimal for all invertebrate species.

In the LCRRA, NWFSC surveys are primarily focused on catching juvenile salmonids but small numbers of invertebrates have been captured and released during purse seine surveys. These species were not the subject of the research and were thus not weighed or counted but included unidentified comb jellies, several genera of jellyfish, and several crab species. Research activities in the LCRRA do not include bottom trawls or other gears that may impact benthic habitat. Overall, NWFSC research activities in the LCRRA do not involve any mechanism for effects on invertebrates at the population level.

Table 4.2-18 Average Annual NWFSC Research Catch of Invertebrates with some Comparisons to Commercial Catch (Landings)

Species are listed in descending order of total research catch by weight. Only species/groups with total catch greater than one metric ton (1,000 kgs) are listed.

Species	Status of the Stock ¹	Average Annual Catch in CCRA (metric tons) (2008-2012)	Average commercial landings per year (metric tons) (2008-2012)	Average research catch compared to commercial landings (percentage)
Ocean pink shrimp	Not overfished	11.2	21,847.9	0.05%
Humboldt squid	NA	10.2	NA	
Brisaster sea urchins	NA	9.6	NA	
Dungeness crab	Not overfished	7.6	25,206.2	0.03%
Fragile red sea urchin	NA	6.4	NA	
Sea urchins and sand dollars	NA	6.3	NA	
Grooved tanner crab	NA	2.8	NA	
Sponges	NA	2.2	NA	
Sea nettle	NA	2.0	NA	
Red star	NA	1.9	NA	

Species	Status of the Stock ¹	Average Annual Catch in CCRA (metric tons) (2008-2012)	Average commercial landings per year (metric tons) (2008-2012)	Average research catch compared to commercial landings (percentage)
Market squid	Not overfished	1.6	96.2	1.7%
Rough anemone	NA	1.3	NA	
Moon jellies	NA	1.3	NA	
Oval sea biscuit	NA	1.2	NA	
Jellyfish spp.	NA	1.1	NA	

1. Source: Commercial catch data from NMFS Office of Sustainable Fisheries website:
<http://www.st.nmfs.noaa.gov/commercial-fisheries/commercial-landings/annual-landings/index>

Physical Damage to Infauna and Epifauna

NWFSC bottom trawl surveys and other bottom contact gear can impact infauna and epifauna invertebrates in sand, silt, and gravel substrates. Infauna live in the seafloor or within structures that are on the seafloor and include clams, tubeworms, and burrowing crabs that usually construct tubes or burrows and commonly occur in deeper and subtidal waters. Epifauna, including mussels, crabs, starfish, sponges, and corals live on the surface of the seafloor or on structures on the seafloor such as rocks, pilings, or vegetation. They either attach to these surfaces or range freely over them by crawling or swimming. Fishing gear that contacts the seafloor can disturb infauna and epifauna by crushing them, burying them, removing them, or exposing them to predators, and thus can reduce complexity and species diversity (Collie et al. 2000, Morgan and Chuenpagdee 2003). The level of biological damage to infauna and epifauna can vary from very minimal with infrequent disturbance to severe with repeated disturbance in the same areas (Stevenson et al. 2004). Since most research surveys are conducted with randomly selected sample sites every year, the potential for repeated disturbance to an area is very low.

Organisms such as cold water corals create structure on the seafloor that may provide important habitat for many organisms, including fishes (Auster and Langton 1999, Stevenson et al. 2004). Cold water corals are generally slow growing, long-lived, and fragile, which makes them particularly vulnerable to damage. Bottom contact fishing gear can break or disrupt corals, thereby reducing the structural complexity of habitat, which may lead to reductions in the species diversity of the corals and other animals that utilize this habitat (Freiwald et al. 2004).

The removal of structural organisms may only be reversible through natural recovery that may occur over hundreds of years (Freiwald et al. 2004). Potential effects on organisms that produce structure would be independent of what season the research was conducted because the organisms are not mobile and could take long periods to recover.

The Groundfish Bottom Trawl Survey does reconnaissance at potential sample sites, using nautical charts and sonar, and does not trawl in high-relief areas that are favored by corals. This selectivity for trawlable bottom habitats (e.g. sand, silt or gravel bottoms with few large rocks) is intended to limit the risk of tearing or losing gear on snags but it also functions to minimize impacts on structural organisms such as hard corals. It is possible that NWFSC research activities could cause damage to corals and other organisms that produce structure in benthic habitats outside of known coral zones. However, catch records from Groundfish Bottom Trawl Survey indicate that an average of 55 kgs of soft and hard corals (all species and types combined) were caught during NWFSC research in the CCRA from 2008 through 2012. The magnitude and geographic extent of potential impacts to benthic organisms due to NWFSC

research activities would be considered minor. Such impacts could be long-term for some species such as slow-growing corals but temporary or short-term for other species.

Changes in Species Composition

Massive removals of marine invertebrate species from an ecosystem could potentially alter community structure and predator-prey relationships at possibly unsustainable levels (Donaldson et al. 2010). Commercially important invertebrate species are managed under FMPs with the management intent to harvest at rates that promote optimal yield, with an increasing emphasis on taking ecosystem considerations into account when setting harvest levels. In commercial fisheries, bycatch is either returned to the sea or landed if it has adequate commercial value and is allowed by the appropriate FMP. Bycatch can be minimized through gear and operational modifications, including localized fishing closures.

Studies conducted on cumulative impacts of benthic disturbance found that chronic commercial trawling reduced benthic biomass by approximately 50 percent (Hiddink et al. 2006). Species richness and the functional composition of benthic communities were also impacted. Species most affected by the trawling were permanently attached species, larger bodied and longer-lived species, and filter-feeders, while scavengers, burrowers, and short-lived and small species were not significantly affected (Hiddink et al. 2006, Tillin et al. 2006). Despite large reductions in infauna and epifauna biomass in intensively trawled areas, the mean trophic level of the benthic communities and trophic relationships within the communities were relatively unchanged (Jennings et al. 2001). The study concluded that trophic structure of intensively trawled benthic invertebrate communities may be a robust feature of the ecosystem studied. Contrary to the intensive and chronic bottom trawling conducted by commercial fisheries in localized regions of high catch probability, NWFSC research bottom trawl surveys are of short duration, generally of randomized design, are rarely repeated in the same location over time, and are collectively much smaller in scale. They are, therefore, likely to have only minor and short-term effects on benthic communities.

Contamination or Degradation of Habitat

Fishing activities involving bottom trawl gear and other bottom-contact gear can physically disturb benthic habitat used by invertebrate species. Such effects can include furrowing and smoothing of the sea floor (Morgan and Chuenpagdee 2003). Physical effects to the sea floor from fishing gear increase with increasing frequency and duration. In addition, bottom trawl activities can locally increase turbidity which may interfere with feeding activities of filter-feeding organisms.

However, many research surveys conducted by the NWFSC are stratified random designs, meaning the exact location of a survey trawl is randomly determined each year within an area of interest. Repeated trawls in the same location are rare or infrequent. Research tows are also limited to 20 minutes so the footprint of each tow is very small. An analysis of the area involved in bottom trawl surveys in Section 4.2.1 indicates that research surveys in the Status Quo Alternative would cover much less than 0.1 percent of the CCRA in any given year. Recovery time from trawl surveys in the soft-bottom environments they target is estimated to be less than two years (Jennings et al. 2001). Therefore, effects to invertebrate habitat from research surveys are expected to be minor in magnitude and short-term in duration.

The potential for research vessels to cause degradation of benthic and pelagic habitat through contamination would only be through accidental spills and discharges, which would likely be limited in magnitude, rare, and localized for the reasons described in Section 4.2.3.

4.2.7.1 Conclusion

NWFSC-affiliated fisheries research conducted under the Status Quo Alternative could have direct and indirect effects on many invertebrate species through mortality, physical damage to infauna and epifauna, changes in species composition, and contamination or degradation of habitat.

For all invertebrate species targeted by commercial fisheries and managed under Fishery Management Plans, mortality due to research surveys and projects is less than two percent of commercial harvest and is considered to be minor in magnitude for all species. Mortality for all species would be distributed across a wide geographic area rather than concentrated in particular localities and the risk of altering benthic community structure would be minimal. Disturbance of animals and benthic habitats from research activities would be temporary and minor in magnitude for all species. As described in Section 4.2.1, the potential for accidental contamination of marine habitats from accidental spills from research vessels is considered unlikely and would be minor in magnitude and temporary or short-term in duration. The overall direct and indirect effects of the Status Quo Alternative on invertebrates would be minor in magnitude, dispersed over a large geographic area, and temporary or short-term in duration and would therefore be considered minor adverse according to the impact criteria in Table 4.1 1.

In contrast to these adverse effects, NWFSC-affiliated research also provides long-term beneficial effects for managed invertebrate species throughout the West Coast Region through its contribution to sustainable fisheries management. The NWFSC conducts stock assessment, habitat research, and bycatch reduction research for several invertebrate species that are important for commercial and recreational fisheries. Scientific information from the NWFSC on the status and trends of lower trophic levels is crucial for understanding the health of the marine environment and is incorporated into ecosystem-based management models. The beneficial effects of the oceanographic and fisheries time-series data provided by NWFSC research programs are especially valuable for tracking long-term trends in the marine environment important to invertebrate populations.

4.2.8 Effects on the Social and Economic Environment

This section describes the effects of NWFSC fisheries and ecosystem research conducted under the Status Quo Alternative on socioeconomic resources of the West Coast Region. Major factors that could be influenced by the NWFSC research program include:

- Collection of scientific data used in sustainable fisheries management
- Economic support for fishing communities
- Tribal co-management of fisheries and marine resources
- Fulfillment of legal obligations specified by laws and treaties

4.2.8.1 Collection of Scientific Data used in Sustainable Fisheries Management

The NWFSC fisheries research program has the most potential to affect the social and economic environment through its contribution to the fisheries management process. The Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended by the Sustainable Fisheries Act, establishes a collaborative fisheries management process with key roles for NOAA Fisheries, the regional Fishery Management Councils, and the Interstate Marine Fisheries Commissions. These entities jointly develop Fishery Management Plans (FMP) for the Nation's fishery resources through extensive discussions with states, tribes, other federal agencies, the commercial fishing industry, public interest groups, universities, and the general public, and through partnerships with international science and management organizations. Under the MSA, FMPs must contain conservation and management measures which prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery. The MSA defines optimum yield as:

- A. the amount of fish which will provide the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities, and taking into account the protection of marine ecosystems;
- B. is prescribed as such on the basis of the maximum sustainable yield from the fishery, as reduced by any relevant economic, social, or ecological factor; and
- C. in the case of an overfished fishery, provides for rebuilding to a level consistent with producing the maximum sustainable yield in such fishery.

Among other considerations, FMPs must also contain provisions to conserve essential fish habitat, minimize bycatch and the mortality of bycatch, and provide for the sustained participation of fishing communities while minimizing adverse economic impacts on them, to the extent practicable and consistent with conservation aims and requirements. In carrying out Congress's mandate under the MSA, NOAA Fisheries is responsible for ensuring that management decisions involving fishery resources are based on the highest quality, best available scientific information on the biological, social, and economic status of the fisheries.

Under the Status Quo Alternative, the long-term, standardized resource surveys conducted by the NWFSC and its cooperative research partners, as summarized in Table 2.2-1, provide a rigorous scientific basis for the development of fisheries stock assessments and federal fishery management actions in the West Coast region. The extended time-series of data helps identify trends that inform fisheries management planning. This information is essential to establishing annual species-specific sustainable harvest limits on an optimal yield basis. Many Status Quo research surveys also provide important comparative information on open, managed, and closed fishing areas, such as the differences between recovery rates, biodiversity, and species density that is vital to assessing the success of fisheries management measures. NWFSC fisheries research also provides information on ecosystem characteristics that is essential to management of commercial fisheries. Climate change and increase in ocean acidification have the potential to impact the population and distribution of marine species. Long-term, predictable marine research provides information on changes to and trends regarding the marine ecosystem that must be considered by fisheries managers. The scientific information provided by the NWFSC is therefore used not just for current management decisions, but also to conserve resources and anticipate future trends, ensure future fishing utilization opportunities, and assess the effectiveness of the agency's management efforts.

The fisheries management process can be contentious when fisheries stocks are relatively scarce and resources must be rationed and allocated among competing commercial, tribal, recreational, and environmental interests. Past overfishing practices have led to depleted stocks and, under mandates from the MSA to establish harvest limits to halt overfishing and rebuild depleted stocks, the fishery management process has imposed significant reductions in harvest limits for some fisheries in order to rebuild stocks of overfished species. These reductions in harvest limits have resulted in adverse economic impacts on certain sectors of the fishing industry with associated adverse social impacts on fishing communities. However, rebuilding stocks important to commercial, tribal, and recreational users would result in long-term beneficial effects on the economies and social relations and cultural institutions of many fishing communities along the West Coast. Scientific data provided through the long-term and short-term fisheries research conducted and associated with the NWFSC has played an important role in the development of fisheries and conservation policies through informing the fisheries management process.

4.2.8.2 Economic Support for Fishing Communities

One of the ways the NWFSC research activities support the social and economic environments is through its role in supporting commercial, tribal, and recreational fisheries management in the West Coast. In

2012, combined U.S. commercial and recreational saltwater fishing generated more than \$199 billion in sales and supported 1.7 million jobs (NMFS 2013c). In 2011, commercial fishermen on the West Coast landed 1.2 billion pounds of finfish and shellfish, earning \$710.5 million in landings revenue. Overall, commercial fishing (exclusive of imports) contributed to 58 thousand jobs, \$3.7 billion in sales, and \$2.0 billion in value added. In that same period, 1.5 million recreational anglers took 6.1 million trips. Overall, recreational fishing contributed to 15.8 thousand jobs, \$1.9 billion in sales, \$662.0 million in income, and \$1.03 billion in value added (NOAA 2011).

In addition, the majority of commercial, tribal, and recreational fishermen value fishing as much for the activity itself and the part it plays in their way of life and cultural traditions as they do for the money they earn and nutritional value of the seafood (Holland and Ditton 1992, Pollnac and Poggie 2008, Smith and Clay 2010). In some cases, fishermen will even subsidize fishing with income from another job in order to stay on the water (Veltre and Veltre 1983, Doeringer et al. 1986). Further, recreational fishing can also include some subsistence fishing, potentially based on ethnicity, gender or location (Toth and Brown 1997, Steinback et al. 2009).

Within this context, social and economic data collection and analysis in the West Coast allows for determination of the relative social and economic impacts of a set of proposed management alternatives. Where conservation outcomes are similar, NMFS attempts to choose alternatives with the most positive or, at a minimum, lowest negative social and economic impact on fishermen, the fishing industry, related shore side industries, and fishing communities.

Another way the NWFSC contributes to the social and economic environments is through direct expenditures on fisheries research. The NWFSC's annual spending fluctuates, but has been around \$80 million from all sources in recent years (NWFSC Operations Management and Information Staff pers. comm. 2014). This spending has direct and indirect beneficial economic effects on the communities and ports in the West Coast region through expenditures in support of NOAA vessels, chartered vessels, and research facilities as well as providing employment and contracted services that contribute to local economies. Some commercial fishing operations are compensated for participation in cooperative research projects through grants or shares in fishing quotas that they sell on the market. Other cooperative research partners, including state agencies, universities, and commercial fishing associations, receive funding through the NWFSC which supports their employees, research vessels, and facilities and therefore supports a large number of local economies. Altogether, the NWFSC currently spends approximately \$7.5 million annually in support of the fisheries research activities covered in the Status Quo Alternative, not including capital costs of vessels and facilities (NWFSC Operations Management and Information Staff pers. comm. 2014). This includes ship time, staff time, equipment, materials, logistics costs, and contracts.

Funding for cooperative research programs has fluctuated widely in the past. The average amount of money distributed through the various cooperative research efforts administered through the NWFSC has averaged about \$10 million in recent years. Similarly, in addition to benefits of social and economic research to the fisheries management enterprise, NWFSC supplies contracts and grants to individual social science researchers and to academic and other institutions throughout the West Coast that conduct social science research on how humans impact and are impacted by ecosystems, climate change, interactions with protected species, wind energy development, and other issues.

The magnitude of the economic impacts of NWFSC fisheries research activities must be placed in the context of regional and local economies according to the impact criteria in Table 4.1-1. While the contribution of research-related employment and purchased services is undoubtedly important and beneficial for many individuals and families, the total sums spent for research are very small compared to the value of commercial, recreational, and tribal fisheries in the area as well as the overall economy of those communities. The contribution of NWFSC research is relatively larger for some communities where the research is centered and may be considered moderate in magnitude for those communities but the

overall direct impact would be minor in magnitude for most communities. These direct impacts would be certain to occur under the Status Quo Alternative, would affect numerous communities throughout the region, and would be long-term and beneficial. Overall, the beneficial economic impacts of NWFSC fisheries research activities would be considered minor to moderate according to the impact criteria in Table 4.1-1.

There are certainly indirect impacts of fisheries research to the economic status of fishing communities but these impacts are filtered through a long and complicated fisheries management environment. It is not possible to assign a monetary value to these indirect impacts although, as stated before, these impacts are generally considered beneficial to fishing communities through their contribution to sustainable fisheries management. In any case, fisheries management decisions by the Fishery Management Councils and NMFS are subject to their own NEPA compliance processes where these types of economic impacts are analyzed in depth so they will not be assessed in this DPEA.

4.2.8.3 Tribal Co-management of Fisheries and Marine Resources

The federal government has the legal obligation to manage fishery resources and to protect and enhance the fish and shellfish resources used by the tribes of the Pacific Northwest. As outlined in Section 3.3.4, multiple laws and treaties protect the sovereign nation status of Native American tribes along the West Coast and ensure the protection of tribal fishing rights, which includes the harvest of marine resources such as groundfish, anadromous fish, and shellfish. Under the Status Quo Alternative, the NWFSC fisheries research program works toward fulfilling these trust obligations by providing rigorous scientific data for the development of fisheries stock assessments and federal fishery management actions in the West Coast region, discussed in Section 4.2.8.1. The survey data from NWFSC research surveys thereby provides the scientific basis for fisheries management in the region. As a result, many treaty tribes have established partnerships with the NWFSC to participate in survey effort and utilize survey results to manage, protect and enhance tribal shellfish, salmon, steelhead, and groundfish resources. Through these co-management partnerships, data on fisheries, habitat, financial, and logistics resources are shared among all partners to enable effective co-management of fisheries resources. The surveys conducted by the NWFSC under the Status Quo directly support these co-management efforts towards fulfillment of the federal obligations to manage and protect tribal fisheries and marine resources, guaranteed by the laws and treaties governing tribal trust status (see Section 6).

As affirmed in the Boldt Decision (see Section 3.3.4), tribal treaty rights include the right of access to usual and accustomed fishing grounds and a right of up to 50 percent of the fin and shellfish that pass through or are present in a tribe's usual and accustomed fishing grounds. The NWFSC fisheries research program, under the Status Quo, has the most potential to directly affect marine resources that are either within the tribe's usual and accustomed fishing grounds (shellfish) or that pass through these areas (including Pacific halibut, Pacific hake, and salmonids). However, strong working relationships between NWFSC researchers and tribal authorities have been developed to help ensure that NWFSC research activities would not restrict access to tribal resources or interfere with tribal harvest activities at usual and accustomed fishing grounds. Although subsistence and tribal commercial fishing equipment is often used within the same regions as those where NWFSC research activities occur, NWFSC survey activities are coordinated to avoid interference and would have a minimal effect on access to tribal usual and accustomed fishing grounds.

Under the Status Quo, the NWFSC fisheries research program may directly affect fish and other maritime resources considered important to tribes. These effects primarily would involve the removal of fish and invertebrates through sampling with various gear types, interactions with protected species, possible habitat modification, and the risk of accidental spills or contamination from vessel operation. Of these effects, those surveys that involve direct impacts to juvenile and adult salmon would have the greatest effect on tribal marine resources. However, potential impacts of NWFSC research on fish and invertebrate

populations would be small in magnitude, disbursed over wide geographic areas, and short-term or temporary; they are considered minor adverse for all species (see Sections 4.2.3 and 4.2.7). And, while usual and accustomed tribal fishing areas include inshore as well as offshore habitats, impacts on habitat modification would also be minimal. The use of bottom trawl research gear, primarily in the CCRA (see Table 2.2-1 and Section 4.2.3) would have little impact due to the narrow amount of area affected (see Section 4.2.1.1). For inshore areas, there would also be little to no impact on habitat because research efforts along the shore are limited to beach seines, various small nets, and fish traps (Table 2.2-1).

The socioeconomic outlook of the tribal entities would not be adversely impacted by NWFSC research activities or the limited impacts to physical and biological resources, such as by reducing or limiting the number of fish or shellfish resources available to tribes. The NWFSC research survey data would also provide an economic benefit to the tribes by providing the basis for fisheries management in the region, thereby providing an economic benefit to tribes by contributing to the long-term sustainable co-management of fishery resources and the resulting social and economic benefits. Under the Status Quo Alternative, NWFSC research activities would continue at current levels and cooperative research relationships would be maintained in order to conserve tribal resources.

4.2.8.4 Fulfillment of Legal Obligations Specified by Laws and Treaties

Chapter 6 provides a list of laws and treaties applicable to the NWFSC fisheries research program. These obligations include the 1996 amendment to the MSA, which requires assessment, specification, and description of the effects of conservation and management measures on participants in fisheries, and on fishing communities (NMFS 2007d). The NWFSC fisheries research programs help fulfill these obligations under the MSA for the West Coast region. In addition, research conducted by the NWFSC contributes to co-management agreements with Native American tribal entities and helps fulfill U.S. treaty obligations.

4.2.8.5 Conclusion

NWFSC-affiliated fisheries and ecosystem research conducted under the Status Quo Alternative would provide a rigorous scientific basis for fisheries managers to set optimum yield fishery harvests, assist in the recovery of overfished and ESA-listed species and ultimately rebuilding these stocks to appropriate levels, and contribute to the protection of tribal fishery resources. It also contributes directly and indirectly to local economies, promotes collaboration and positive relationships between NMFS and tribal fishery managers as well as with commercial/recreational, and tribal fishing interests, and helps fulfill NMFS obligations to communities and tribes under U.S. laws and treaties.

The direct and indirect effects of the Status Quo Alternative on the social and economic environment would be certain to occur, minor to moderate in magnitude depending on the community, long-term, and would be felt throughout the West Coast region. According to the impact criteria established in Table 4.1-1, the direct and indirect effects of the Status Quo Alternative on the social and economic environment would be minor to moderate and beneficial.

4.3 DIRECT AND INDIRECT EFFECTS OF ALTERNATIVE 2 - PREFERRED ALTERNATIVE

This section presents an analysis of the potential direct and indirect effects of Alternative 2 – Preferred Alternative on the physical, biological, and social environment. Under this Alternative, the NWFSC would conduct a new suite of research activities and implement new mitigation measures in addition to the Status Quo program to comply with the MMPA and ESA compliance process. The new suite of research activities is a combination of past research and additional, new research. Potential direct and indirect effects were evaluated according to the criteria described in Table 4.1-1. A summary of the impact rating determinations for all topics evaluated under Alternative 2 is presented below in Table 4.3-1.

Table 4.3-1 Alternative 2 Summary of Effects

Resource	Physical Environment	Special Resource Areas	Fish	Marine Mammals	Birds	Sea Turtles	Invertebrates	Social and Economic
Section #	4.3.1	4.3.2	4.3.3	4.3.4	4.3.5	4.3.6	4.3.7	4.3.8
Effects Conclusion	Minor adverse	Minor adverse	Minor adverse	Minor adverse	Minor adverse	Minor adverse	Minor adverse	Minor to Moderate beneficial

4.3.1 Effects on the Physical Environment

The effects of the Preferred Alternative on the physical environment would be similar to those of the Status Quo Alternative (Section 4.2.1). The additional mitigation measures for protected species proposed under the Preferred Alternative would not change the effects of the research activities on physical properties of the environment. The changes to the suite of research activities conducted under the Preferred Alternative would result in minimal changes to the physical effects to the benthic environment relative to the Status Quo Alternative. Therefore, the overall effects of The Preferred Alternative on the physical environment would be minor in magnitude, dispersed over a large geographic area, and temporary or short-term in duration, and would therefore be considered minor adverse according to the impact criteria in Table 4.1-1.

4.3.2 Effects on Special Resource Areas

NWFSC-affiliated fisheries research conducted under the Preferred Alternative would have the same types of effects on special resource areas as described for the Status Quo Alternative (Section 4.2.2). There are small changes in the research projects conducted under the Preferred Alternative (Table 2.3-1) that would likely have minimal effects on the catch rate and species of fish and invertebrates caught relative to the Status Quo. However, none of these changes would impact the types of gear used or level of research effort within EFH Closed Areas, Marine Protected Areas, or National Marine Sanctuaries. The level of research effort using bottom trawl gear would remain the same so potential impacts to benthic habitat would be as described in the Status Quo.

The additional mitigation measures for protected species proposed under the Preferred Alternative would not change the effects of the research activities on the physical components of the environment or most biological components; they would only tend to decrease effects on protected species, which were considered minor adverse under the Status Quo Alternative. The addition of a marine mammal excluder device on the Nordic 264 surface trawl used in the Juvenile Salmon PNW Coastal Survey could affect the

selectivity of fish species caught within the Olympic Coast Sanctuary, especially juvenile salmon, but the NWFSC is conducting experiments with the design of the excluder to minimize those differences. Overall impacts on salmonids within the Sanctuary would likely be very small.

The overall effects of the Preferred Alternative on special resource areas would be minor in magnitude, dispersed over a large geographic area, and temporary or short-term in duration, and would therefore be considered minor adverse according to the impact criteria in Table 4.1-1. As was the case for the Status Quo Alternative, the scientific data generated from NWFSC research activities under the Preferred Alternative would also have beneficial effects on special resource areas, including National Marine Sanctuaries, through their contribution to science-based conservation management practices.

4.3.3 Effects on Fish

NWFSC-affiliated fisheries research conducted under the Preferred Alternative would have the same types of effects on fish species as described for the Status Quo Alternative (Section 4.2.3) through mortality, disturbance, and changes in habitat. There are small changes in the research projects conducted under the Preferred Alternative (Table 2.3-1) that could affect the catch rate or species of fish caught relative to the Status Quo, including:

- Addition of mid-water trawls with small mesh cod-ends targeting ESA-listed Pacific eulachon entering the Columbia River
- Additional broodstock collection of various species with several gear types
- Elimination of bottom trawl efforts in the Hake Acoustics Survey
- Increased hook-and-line effort for live-capture and tagging projects
- Substantial reduction in surface trawl efforts in two Puget Sound projects
- Targeted hook-and-line efforts for live-capture of ESA-listed rockfish for genetic sampling

Several other projects also either add or subtract video camera equipment, plankton sampling, scuba divers, or other minor gears that would not affect catch of fish. None of the differences between the Preferred Alternative and the Status Quo Alternative would substantially change the potential impacts of research on benthic habitat, the risk of accidental contamination, or critical habitat for ESA-listed species. These potential effects were considered minor adverse under the Status Quo Alternative because of their relatively low magnitude, temporary duration, dispersal over time and space, and, in the case of contamination, the small risk of occurrence (Section 4.2.3). These types of effects would also be considered minor adverse under the Preferred Alternative for the same reasons. The following discussion will therefore focus on potential effects through mortality of fish.

4.3.3.1 ESA-listed Species

Mortality from Fisheries Research Activities

Non-salmonids

Two of the new projects initiated under the Preferred Alternative would target ESA-listed species and would therefore operate under ESA Section 10 directed research permits. The Eulachon Arrival Timing project would attempt to capture Pacific eulachon entering the Lower Columbia River estuary in a modified mid-water trawl. These trawls would be dispersed over the late winter months and would be very short in duration (15 minutes). Fish caught in these trawls would be sampled, with some individuals sacrificed for fecundity measurements and other biological data, but most fish would be released alive after processing if possible. The ESA-listed Rockfish Genetics project would target ESA-listed rockfish

in Puget Sound using hook-and-line gear (deployed by rod and reel) designed to inflict minimal damage to captured fish. This project would take non-lethal tissue samples from fins for genetic testing and record other morphometric measurements important to understanding the life history and health status of these species. The research would be conducted with protocols designed to minimize the risk of injury during handling of all fish and all fish would be released unharmed if possible, utilizing descending devices if necessary to return fish to deep water with minimal injury.

The increased effort to collect broodstock in all three NWFSC research areas have the potential to increase the number of interactions with ESA-listed rockfish or other species. However, the specific locations where such research would be conducted and the protocols have not been determined yet. Such details would greatly influence the risk of catching ESA-listed rockfish or any other ESA-listed species. These and other factors would be considered before scientific research permits were issued for any future research with this gear.

It is assumed that potential impacts on ESA-listed rockfish or any other ESA-listed species would be similar under the Preferred Alternative as they were in the Status Quo Alternative (Section 4.2.3.1). Under the Preferred Alternative, the anticipated impacts of NWFSC research on ESA-listed non-salmonids would be low in magnitude, would occur rarely or infrequently, would be dispersed over time and space, and would therefore be considered minor adverse according to the impact criteria in Table 4.1-1.

Salmonids

Under the Preferred Alternative, sampling effort with surface trawls would be reduced by 50 percent relative to the Status Quo Alternative (from 500 trawls to 250 trawls) in the Puget Sound Marine Pelagic Food Web project. This project accounts for about 75 percent of the juvenile chum salmon and 50 percent of the juvenile Chinook salmon caught under the status quo in the PSRA. Surface trawl effort in the Skagit Bay Juvenile Salmon Survey would also be reduced by about a third (from 250 trawls to 180 trawls). This project has caught salmonids from all six species under the status quo and accounts for the majority of ESA-listed bull trout caught under the status quo. The substantial reduction in fishing effort for both of these research projects should result in corresponding reductions in catch of ESA-listed salmonids in the PSRA. No other changes in research protocols under the Preferred Alternative are likely to affect the potential for catching ESA-listed salmonids.

The NWFSC considers the potential for adverse impacts of its various research activities on ESA-listed salmonids to be very small in magnitude, dispersed in time and geographic area, and likely to have minimal impact on all ESUs in all three research areas. In contrast to these minor adverse effects, NWFSC research on Pacific salmon has beneficial impacts on both ESA-listed and non-listed ESUs through its contribution to sustainable fisheries management, reducing bycatch of vulnerable ESUs, helping to monitor the recovery of ESA-listed species, and monitoring changes in the marine environment important to the recovery of these species. Overall, the impact of NWFSC research on ESA-listed salmonids under the Preferred Alternative is considered minor adverse according to the impact criteria described in Table 4.1-1.

4.3.3.2 Target and Other Species

Mortality from Fisheries Research Activities

California Current Research Area

Under the preferred alternative, the amount of fish caught in hook-and-line surveys is very small relative to the amount of fish caught in trawl surveys in the CCRA, which would remain very similar to the status quo. Other changes in Preferred Alternative projects, such as broodstock collection and tagging projects,

would also have minimal impacts on the total fish caught relative to the expected trawl efforts. Expected catch of target and other species would therefore be similar to levels caught during the status quo period (Table 4.2-13), which is considered relatively small in magnitude for all species compared to average harvest and population metrics.

The issues concerning overfished species or other species with conservation concerns would be the same under the Preferred Alternative as described for the Status Quo Alternative (Section 4.2.3.2). Most research activities conducted by the NWFSC are multi-species surveys that cover large areas, involve minimal sampling, and do not target overfished species. Research catches in these surveys are generally very small for uncommon species. However, bycatch reduction research projects are often focused on a particular species or group of fish (e.g., rockfish) and could catch substantial amounts of targeted fish in a relatively small area (e.g. studies comparing different configurations of commercial fishing gear). Such research directed at an overfished stock could theoretically account for a substantial portion of the annual catch limit for that stock and could interfere with the rebuilding plan for that stock.

Research data is necessary for monitoring the status of overfished stocks and other stocks of conservation concern and to determine if management objectives for rebuilding those stocks are being met. Under the Preferred Alternative, proposals for scientific research projects must go through a rigorous process to get scientific research permits or experimental fishing permits. The potential impacts of those proposed projects are assessed for each stock, including overfished stocks, before those permits are issued. Fisheries managers typically consider the estimated amount of research catch from all projects along with other sources of mortality (e.g., bycatch in other fisheries and predation) before setting commercial fishing limits to prevent overfishing of stocks or to help overfished stocks rebuild. This type of annual review of research proposals would continue to occur in the future under the Preferred Alternative. Any future proposed projects targeting overfished stocks, or projects likely to have substantial bycatch of an overfished stock, would receive additional scrutiny on a stock by stock basis to ensure minimal impact on the stock before a research permit is issued. These permitting reviews would also determine whether the proposed projects were consistent with the NEPA analysis presented in this DPEA or whether additional NEPA analysis was required (see Section 2.3.5).

Table 4.2-13 indicates that, while mortality to fish species is a direct effect of the NWFSC surveys and research projects, there are likely no measurable population changes occurring as a result. Mortality incurred during research represents a small percentage of fish taken in commercial fisheries, which are just fractions of the total populations for these species. For all target species in the CCRA, mortality from NWFSC research activities would be low in magnitude, dispersed over a wide geographic area, and therefore considered minor adverse for all target species under the Preferred Alternative according to the criteria in Table 4.1-1.

Puget Sound Research Area

The Preferred Alternative would include substantially reduced research effort in two projects using surface trawls in the PSRA. These two projects catch large numbers of small fish, including the majority of juvenile salmon and other small forage fish species caught under status quo conditions. The reduction in trawl effort for these two projects would be expected to substantially reduce the numbers of all fish caught in the PSRA. However, the impacts from these projects were already considered minimal for all species under the Status Quo Alternative and expected impacts under the Preferred Alternative would be even less. The ESA-listed Rockfish Genetics project would probably include catch of unlisted fish in the PSRA but proposed effort in this project indicates catch rates would likely not change the relative magnitude of research catch or species caught in the PSRA. Similarly, there are no changes to other project protocols under the Preferred Alternative that would have an effect. Under the Preferred Alternative, NWFSC research activities would result in the mortality of very small quantities of fish from the PSRA, most of which would be juvenile fish or forage fish species. For all target species in the PSRA,

mortality from NWFSC research activities would be low in magnitude, dispersed over a wide geographic area, and therefore considered minor adverse for all target species under the Preferred Alternative according to the criteria in Table 4.1-1.

Lower Columbia River Research Area

There are no changes in research programs or protocols under the Preferred Alternative that would likely affect the relative magnitude of research catch or species caught in the LCRRA compared to the Status Quo Alternative. The effects of NWFSC research on fish species in the LCRRA would therefore be very similar to those described for the Status Quo Alternative (Section 4.2.3.2).

Under the Preferred Alternative, NWFSC research activities would result in the mortality of very small quantities of fish from the LCRRA, most of which would be juvenile fish or forage fish species. For all target species in the LCRRA, mortality from NWFSC research activities would be low in magnitude, dispersed over a wide geographic area, and therefore considered minor adverse for all target species under the Preferred Alternative according to the criteria in Table 4.1-1.

4.3.3.3 Conclusion

NWFSC fisheries research conducted under the Preferred Alternative could have effects on ESA-listed species, commercially and recreationally targeted species, and non-managed fish species through mortality, disturbance, and changes in habitat. Impacts on fish habitats would be limited to temporary and localized increases in turbidity from research bottom-contact gear and, in rare cases, accidental contamination from fuel spills and other compounds from research vessels. Given the spill response equipment and emergency training required of all research vessels by Coast Guard regulations regarding safety and pollution prevention, and the experience of NOAA Corps and charter captains and crew, the potential for accidental fuel spills or other contamination from research vessels is considered small and any incidents would likely be rare, small in magnitude, and quickly contained (Section 4.2.1).

For ESA-listed species, rare or infrequent incidental captures of several non-salmonid species have previously occurred in the CCRA (Pacific eulachon of the Southern DPS) and PSRA (canary rockfish of the Puget Sound/George Basin DPS). Such incidental captures would likely continue to occur on an irregular basis under the Preferred Alternative. Other ESA-listed non-salmonid species could be caught in the three NWFSC research areas but would likely be rare if they occurred. Overall mortality of these species would be of very low magnitude compared to the populations of these species, distributed over relatively large areas, and would occur rarely or infrequently. The effects of the Preferred Alternative on ESA-listed non-salmonids are therefore expected to be minor adverse according to the impact criteria described in Table 4.1-1.

Salmonids have also been caught in the past. Bull trout of the Puget Sound/coastal DPS have irregularly been caught in the PSRA. Juvenile ESA-listed salmon and steelhead are regularly caught in NWFSC research in all three research areas, some of which is directed research on these species in response to needs for information important to the recovery of the species. NWFSC surveys infrequently catch adult salmon in the CCRA, averaging less than 50 fish from all ESUs per year, and many of these fish are released after tagging and measurement without apparent harm. One project in the LCRRA targets adult salmon but uses traps to capture them alive for tagging and release. Many juvenile fish captured in beach seines and tangle nets are also released alive after data recording, further reducing potential impacts. Comparisons of juvenile salmon caught in research to commercial harvests of adult salmon or ESU stock assessments are not useful measurements of impact. The NWFSC considers the adverse impacts of its various research activities on ESA-listed salmonids to be very small in magnitude, dispersed in time and geographic area, and likely to have minimal impact on all ESUs in all three research areas. In contrast to these minor adverse effects, NWFSC research on Pacific salmon has beneficial impacts on both ESA-listed and non-listed ESUs through its contribution to sustainable fisheries management, reducing bycatch

of vulnerable ESUs, helping to monitor the recovery of ESA-listed species, and monitoring changes in the marine environment important to the recovery of these species. Overall, the impact of NWFSC research on ESA-listed salmonids under the Preferred Alternative is considered minor adverse according to the impact criteria described in Table 4.1-1.

For most species targeted by commercial fisheries and managed under FMPs, mortality due to research surveys and projects is less than ten percent of commercial harvest and less than one percent of OFLs and is considered to be minor in magnitude for all species. For a few species which do not have a large commercial market due to various market conditions or past overfishing, the research catch exceeds ten percent of commercial catch but is still less than one percent of OFL for each species and is considered minor in magnitude. Proposed research projects that target stocks that are overfished or where overfishing is occurring are reviewed annually before research permits are issued to determine if they would conflict with rebuilding plans or present other conservation concerns. Mortality for all species would be distributed across a wide geographic area rather than concentrated in particular localities. The overall effects of the Preferred Alternative on non-ESA-listed fish would be minor in magnitude, distributed over a wide geographic area, and temporary or short-term in duration and would therefore be considered minor adverse according to the criteria in Table 4.1-1.

In contrast to these adverse effects, NWFSC research also provides long-term beneficial effects on managed fish species throughout the West Coast Region through its contribution to sustainable fisheries management. Data from NWFSC-affiliated research provides the scientific basis to reduce bycatch, establish optimal fishing levels, prevent overfishing, and recover overfished stocks. The beneficial effects of the time-series data provided by NWFSC research programs effects are especially valuable for long-term trend analysis for commercially harvested fish and, combined with other oceanographic data collected during fisheries research, provide the basis for monitoring changes to the marine environment important to fish populations.

4.3.4 Effects on Marine Mammals

The direct and indirect effects of the Preferred Alternative on marine mammals are very similar to those described for the Status Quo Alternative (Section 4.2.4). Differences between the alternatives that may affect the impacts of NWFSC fisheries research on marine mammals include:

- Improved and formalized protected species training, awareness, and reporting procedures to facilitate and improve implementing mitigation measures (see below).
- Several gear modifications intended to reduce impacts on marine mammals or improve knowledge about how marine mammals may interact with research gear.
- Discontinuation of five projects and the addition or modification of several other projects (Section 2.3, Table 2.3-1)

The following analysis draws heavily on the analysis provided under the Status Quo Alternative (Section 4.2.4), but focuses on differences that may result from the new research elements and mitigation measures added under the Preferred Alternative.

The Preferred Alternative is the NWFSC research program and suite of mitigation measures that are being proposed in the MMPA LOA application (Appendix C). The analysis of effects in the LOA application was based primarily on the history of past effects under status quo conditions, including mitigation measures as they were implemented at the end of 2013. However, the nature of the status quo conditions has changed in the last ten years in terms of the specific research being conducted and the implementation of mitigation measures for protected species interactions. The NWFSC regularly assesses their effects on the marine environment and explores ways to effectively reduce adverse interactions while fulfilling their mission to collect scientific information for fisheries and natural resource management. The Status Quo

Alternative, therefore, reflects the mitigation equipment and procedures as they were implemented through the end of 2013, while the Preferred Alternative includes ongoing efforts to develop new mitigation measures.

The Preferred Alternative includes the same suite of mitigation measures described under the Status Quo Alternative with the following modifications to reduce the risk of adverse interactions with protected species (Section 2.3.2). The NWFSC proposes improvements to its protected species training, awareness, and reporting procedures under the Preferred Alternative in order to facilitate and improve the implementation of mitigation measures described under the Status Quo Alternative. Enhancements include:

- The NWFSC will initiate procedures to facilitate communication between Chief Scientists and vessel captains about protected species interactions during research surveys in order to improve decision-making regarding avoidance of adverse interactions. The intent is to draw on the collective experience of people who have been making those decisions, provide a forum to exchange information about what worked or did not work, apply lessons learned and improve upon future decisions regarding avoidance practices. The NWFSC would coordinate among its staff and vessel captains and with those from other fisheries science centers with similar experience.
- Proposed development of a formalized protected species training program for all crew members that would be required for all NWFSC-affiliated research projects. NWFSC Chief Scientists and appropriate members of NWFSC research crews will be trained using customized monitoring, data collection, and reporting protocols for protected species developed with assistance from the Northwest Fisheries Observer Program (NWFOP).
- This would formalize and standardize the information provided to all crew that might experience protected species interactions during research activities.
- For all NWFSC-affiliated research projects and vessels, instructions and protocols for avoiding adverse interactions with protected species will be reviewed and, if needed, made fully consistent with the customized protected species training materials and any guidance on decision-making that arises from training opportunities. Informational placards and reporting procedures will be reviewed and updated as necessary for consistency and accuracy. The NWFSC will incorporate specific language into its contracts that specifies all training requirements, operating procedures, and reporting requirements for protected species that will be required for all vessels, including charter vessels and cooperating research partners.

In addition, NWFSC is proposing several gear modifications under the Preferred Alternative to mitigate and monitor interactions with marine mammals, including:

- The Juvenile Salmon PNW Coastal Survey will include a marine mammal excluder device (MMED) on the Nordic 264 surface trawl, along with high-resolution video cameras on some tows. The cameras will be used to evaluate effects of the MMED on catch and to determine detection and escape rates of marine mammals out of the net or through the MMED.
- The NWFSC is testing the potential to replace the pair trawl net used in the Pair Trawl Columbia River Juvenile Salmon Survey with a flexible towed matrix of large coiled antennas for PIT-tag detection. This should eliminate the potential for marine mammal interactions and the need to employ deterrence techniques for nuisance pinnipeds (e.g., skiff sentinels, pyrotechnics, seal bombs).
- The Groundfish Bottom Trawl Survey will add video cameras to the trawl net to identify fish and to study fish behavior as they enter the net. Even though no marine mammals have been caught in

NWFSC bottom trawls to date, the cameras could provide incidental information about potential interactions with marine mammals, if they enter the net.

The potential effects of the Preferred Alternative on marine mammals involve adverse interactions with research vessels, survey gear, sonar and other active acoustic devices, and other associated equipment, including:

- Disturbance and behavioral responses due to acoustic equipment and the physical presence of researchers
- Injury or mortality due to ship strikes and entanglement in gear
- Changes in food availability due to research survey removal of prey and discards
- Contamination from discharges

These mechanisms of potential effects are discussed under the Status Quo Alternative (Section 4.2.4), most of which will not be repeated here. The mechanism in the first bullet, acoustic disturbance, would be similar under the Preferred Alternative as it is for the Status Quo Alternative because there are few new acoustic sound sources that would be introduced (active acoustics will be added to the Newport Line Plankton Survey, although the types of acoustic devices and protocols used do not differ from those employed under the Status Quo Alternative) and no new mitigation measures are being proposed that would address potential effects due to acoustic disturbance. Although every species of marine mammal in the research area may be exposed to sounds from active acoustic equipment used in NWFSC research, many of the acoustic sources are likely not audible to most species and the others would likely cause temporary and minor changes in behavior for nearby animals as the ships pass through a given area. The overall effects from acoustic disturbance are considered minor adverse for all species in the NWFSC research areas. The potential effects from changes in food availability and contamination were also considered to be minor adverse for all species of marine mammals and will not be discussed further. The following discussion will therefore focus on the potential effects from entanglement or incidental capture in fishing gear used in NWFSC research, especially with regard to any differences between the Status Quo Alternative and the Preferred Alternative.

4.3.4.1 California Current Research Area

ESA-listed Species

The endangered marine mammals that occur in the CCRA include sperm, humpback, blue, fin, and sei whales, and the Southern Resident Distinct Population Segment (DPS) of killer whales, and, periodically, individuals from the western North Pacific stock of gray whales. Threatened species include Guadalupe fur seals and the Southern subspecies of sea otter. Sea otters are under the jurisdiction of the U.S. Fish and Wildlife Service (USFWS), while the other species are under the jurisdiction of NMFS in regards to compliance with the MMPA and ESA.

Injury, Serious Injury, or Mortality due to Entanglement in Gear

There have been no entanglements or takes of current ESA-listed marine mammals in NWFSC CCRA fisheries research and the LOA application does not include any estimated Level A harassment or serious injury and mortality takes of threatened or endangered cetaceans or pinnipeds during the 5-year authorization period. The NWFSC also does not anticipate any future takes of southern sea otters due to their nearshore habitat and lack of overlap with NWFSC research activities. Sea otters are under the jurisdiction of the USFWS and are not covered in the LOA application to NMFS.

In addition to the mitigation measures that have been implemented in recent years under the Status Quo Alternative, the Preferred Alternative includes several new measures that may further reduce the risk of

future marine mammal takes. Measures to mitigate the risk of entanglements are described in Section 2.3.1 and summarized above. Given these measures and the lack of prior entanglements of ESA-listed marine mammals, the likelihood of these types of interactions in fisheries research gear under the Preferred Alternative would be low. The potential effects from entanglement in research gear in the CCRA under the Preferred Alternative are, therefore, considered minor adverse for ESA-listed marine mammal species.

Other Cetaceans

This section describes impacts to cetaceans that are not ESA-listed. Minke whales and gray whales are the only baleen whale species included in this section. The remaining cetaceans are toothed whale species (i.e., odontocetes), including whales, dolphins, and porpoises.

Injury, Serious Injury, or Mortality due to Entanglement in Gear

The analysis of historical takes and estimated takes for cetaceans in the LOA application are the same as presented under the Status Quo Alternative (Section 4.2.4). Potential takes are determined by historical takes in fisheries research (including the worst-case scenario for Pacific white-sided dolphins), species with similar vulnerabilities to historically taken species, and historical takes in analogous commercial fisheries. The NWFSC anticipates that new research and training programs included in the Preferred Alternative would further reduce risks of adverse interactions with marine mammals. However, any attempt to quantitatively estimate how much these enhancements would reduce potential interactions would be speculative so the effects analysis for the Preferred Alternative is based on the estimated marine mammal takes in the LOA application (Appendix C and Table 4.2-16).

The estimated average annual take in all gear types and all research areas combined is well below 10 percent of PBR for almost all stocks (except bottlenose dolphins), even if all annual takes were from a single stock for species with multiple stocks (Table 4.2-16). Potential annual takes of Pacific white-sided dolphins would equal about 3.5 percent of PBR, which, although higher than for some species, is still well under 10 percent of PBR. This level of mortality, were it to occur, would be considered minor in magnitude for all stocks. However, the NWFSC take request also includes “undetermined dolphin or porpoise” takes to account for similar-looking animals that may escape from the net or hook-and-line gear before being brought on board or identified. If, for impact analysis purposes, these undetermined takes are assigned to each stock in addition to those takes requested for the particular stock, the combined take request would still be well below 10 percent of PBR for most stocks and would be considered minor in magnitude. The potential exceptions are for stocks with very small PBR values, i.e. one coastal and one offshore stock of bottlenose dolphin, where these added takes could be moderate in magnitude relative to PBR. However, the assumptions of this worst case scenario are highly unlikely to occur given the lack of historical takes for this species, let alone these particular stocks. The chances of all future “undetermined” delphinids actually coming from any one stock are so remote as to be discountable. In addition, the small population sizes of these stocks, the limited scope of NWFSC research efforts within their ranges, and the mitigation measures in place to avoid marine mammal interactions (see Section 2.2.2) further reduce the risk of gear interactions with these stocks. The NWFSC therefore considers the potential effects of NWFSC research on these stocks to be minor.

These potential mortalities of cetaceans would be rare or infrequent events. Any actual take would occur in a localized area, but since cetaceans generally travel through large geographic areas, the potential loss of an animal would affect more than a localized population. The overall impact of the potential takes of these species, if they occurred, would be considered minor adverse according to the criteria described in Table 4.1-1.

Other Pinnipeds

There are five species of non-ESA-listed pinnipeds commonly found in the CCRA that may interact with NWFSC research: California sea lion, Steller sea lion (Eastern DPS), northern fur seal (two stocks), harbor seal (several stocks), and Northern elephant seal. There are no Level A takes of northern elephant seals anticipated, only Level B acoustic harassment takes (Tables 4.2-14 and 4.2-15).

Injury, Serious Injury, or Mortality due to Entanglement in Gear

The analysis of historical takes and estimated takes for pinnipeds in the LOA application are the same as presented under the Status Quo Alternative (Section 4.2.4), with potential takes determined by historical takes in fisheries research, species with similar vulnerabilities to historically taken species, and historical takes in analogous commercial fisheries. Potential takes of non-ESA-listed marine mammals are as shown in Table 4.2-. The NWFSC anticipates that new research and training programs included in the Preferred Alternative would further reduce risks of adverse interactions with marine mammals. In addition to the mitigation measures that have been implemented in recent years under the Status Quo Alternative, the Preferred Alternative includes several new measures that may further reduce the risk of future marine mammal takes.

Estimated annual takes in trawl and hook-and-line gear are less than one percent for all pinniped species for which PBR is known and would therefore be considered minor in magnitude. Given the low number of pinniped interactions that have occurred in the past and the implementation of current mitigation measures, future mortalities of pinnipeds would likely be rare or infrequent events and would be unlikely to actually occur at this estimated rate during the 5-year authorization period. Any actual take would occur in a localized area, but these animals travel over large geographic areas so the potential loss of an animal would affect more than a localized population. The overall impact of potential takes of pinnipeds in NWFSC research gear in the CCRA, if they occurred, would, therefore, be considered minor adverse under the Preferred Alternative according to the criteria described in Table 4.1-1.

Sea Otters

There are two subspecies of sea otters in the CCRA. The ESA-listed Southern subspecies is discussed above. The Northern subspecies (Washington stock) is included here. This population inhabits nearshore waters along the outer coast of Washington and the Strait of Juan de Fuca, with occasional sightings of small groups (1-2 individuals) in Puget Sound. Although NWFSC research activities occur along the outer Washington coast, almost all of them occur further offshore in deeper waters than are typically used by sea otters. The NWFSC does not anticipate any future Level B or Level A takes of sea otters from this population based on a lack of historical takes and very little spatial overlap between sea otter habitat and NWFSC research activities under the Preferred Alternative.

4.3.4.2 Puget Sound Research Area

ESA-listed Species

The endangered marine mammals that occur in the PSRA include the Southern Resident DPS of killer whales and occasional (rare) sightings of humpback whales.

Injury, Serious Injury, or Mortality due to Entanglement in Gear

The analysis of historical takes and estimated takes for cetaceans in the LOA application are the same as presented under the Status Quo Alternative (Section 4.2.4). The NWFSC anticipates that new research and training programs included in the Preferred Alternative would further reduce risks of adverse interactions with marine mammals. In addition to the mitigation measures that have been implemented in

recent years under the Status Quo Alternative, the Preferred Alternative includes several new measures that may further reduce the risk of future marine mammal takes.

There have been no historical takes of currently listed marine mammals in the PSRA by any NWFSC fisheries research activities. The NWFSC is not requesting the take of any ESA-listed species by trawl or purse seine gear due to lack of historical interactions and the low probability of take due to several factors, including density, abundance, distribution, and behavior of these species. The Movement Studies of Puget Sound Species uses barbless hook-and-line gear and employs mitigation measures that include avoiding fishing when killer whales are within 500 meters (Table 2.2.1).

Additional measures to mitigate the risk of entanglements are described in Section 2.2.1. Vessel captains, bridge officers, and crew watch for marine mammals while underway and while setting fishing gear and take action to avoid them. The lack of entanglements of ESA-listed whales indicates that the risk of these types of interactions in fisheries research gear is low. The potential effects from entanglement in research gear is, therefore, considered minor adverse for threatened and endangered species in the PSRA under the Preferred Alternative according to the criteria described in Table 4.1-1.

Other Cetaceans

This section describes impacts to cetaceans that are not ESA-listed. Minke whales and gray whales are the only baleen whale species included in this section. The other species are toothed whales (odontocetes), including dolphins and porpoises.

Injury, Serious Injury, or Mortality due to Entanglement in Gear

The analysis of historical takes and estimated takes for non-ESA listed cetaceans in the LOA application are the same as presented under the Status Quo Alternative (Section 4.2.4). The NWFSC anticipates that new research and training programs included in the Preferred Alternative would further reduce risks of adverse interactions with marine mammals.

Although Pacific white-sided dolphins and unidentified dolphins/porpoises have previously been taken in NWFSC research, all of these past takes have occurred in the CCRA. Harbor porpoises and Dall's porpoises occur in the PSRA and therefore may interact with NWFSC research activities in the PSRA. The LOA application estimates that one harbor porpoise and one Dall's porpoise may be taken in trawl gear during the 5-year authorization period. If this level of take actually occurred, it would be less than one percent of PBR for both species and would be considered minor in magnitude (Table 4.2-16). The overall impact of the potential takes of these species in the PSRA would be considered minor adverse under the Preferred Alternative according to the criteria described in Table 4.1-1.

Other Pinnipeds

There are three species of non-ESA-listed pinnipeds commonly found in the PSRA that may interact with NWFSC research: California sea lion, Steller sea lion (Eastern DPS), and harbor seal.

Injury, Serious Injury, or Mortality due to Entanglement in Gear

Table 4.2-10 and Figure 4.2-1 show historical takes of pinnipeds by all NWFSC research activities. All takes were in surface trawls. The only take in the PSRA was of a single harbor seal in 2009 during the Skagit Bay Juvenile Salmon Survey. Trawling was stopped when the crew noticed harbor seal activity adjacent to the net, the net was retrieved and the seal was released alive. Measures to mitigate the risk of entanglements are described in Sections 2.2.1 and 2.3.1.

The LOA application includes calculations of the number of pinnipeds that may interact with research gear based on historical takes in NWFSC fisheries research, the similarity of species not previously taken

to those historically taken and historical takes in commercial fisheries operating in similar areas and using similar gear types to fisheries research. The NWFSC is requesting one take each of harbor seal, California sea lion, and Steller sea lion in trawl gear and one take each of harbor seal and California sea lion in hook-and-line gear over the 5-year authorization period in the PSRA (Table 4.2-16).

These estimated take levels are well below ten percent of known or potential PBR for each of these species (Table 4.2-16). This level of mortality would be considered minor in magnitude and would not have population-level effects. The overall impact of the potential takes of these species in the PSRA under the Preferred Alternative would, therefore, be considered minor adverse according to the criteria described in Table 4.1-1.

Sea Otters

The Northern subspecies (Washington stock) of sea otters occurs in the PSRA. This population inhabits nearshore waters along the outer coast of Washington and the Strait of Juan de Fuca, with occasional sightings of small groups (1-2 individuals) in Puget Sound. Although the Strait of Juan de Fuca and Puget Sound are within the PSRA, the NWFSC does not anticipate any future takes of sea otters from this population based on a lack of historical takes and very little spatial overlap between nearshore sea otter habitat and NWFSC research activities under the Preferred Alternative.

4.3.4.3 Lower Columbia River Research Area

ESA-listed Species

The endangered marine mammals that occur in the LCRRA include occasional sightings of Southern resident killer whales at the mouth of the Columbia River. Steller sea lions, previously listed as threatened, were removed from the List of Threatened and Endangered Species in November 2013 and are now included below under Other Pinnipeds.

Injury, Serious Injury, or Mortality due to Entanglement in Gear

There have been no historical takes of ESA-listed marine mammals by NWFSC fisheries research in the LCRRA and the NWFSC is not requesting any future takes in the LOA application. The lack of takes of ESA-listed marine mammals indicates that the risk of these types of interactions in fisheries research gear in the LCRRA is very low. The potential effects from entanglement in research gear is, therefore, considered minor adverse for ESA-listed species throughout the LCRRA during all seasons using gear types similar to those currently in use.

Other Cetaceans

There have been no historical takes of cetaceans in NWFSC research gear in the LCRRA but based on takes in analogous commercial fisheries, the LOA application estimates that one harbor porpoise may be taken in trawl gear and one harbor porpoise may be taken in purse seine or tangle net gear during the 5-year authorization period in the LCRRA. If this level of take actually occurred, it would be less than one percent of PBR for this species and would be considered minor in magnitude (Table 4.2-16). The overall impact of the potential takes of these species in the LCRRA would be considered minor adverse under the Preferred Alternative according to the criteria described in Table 4.1-1.

Other Pinnipeds

There are three species of non-ESA-listed pinnipeds commonly found in the LCRRA that may interact with NWFSC research: California sea lion, Steller sea lion (Eastern DPS), and harbor seal.

Injury, Serious Injury, or Mortality due to Entanglement in Gear

There have been no historical takes of pinnipeds in NWFSC research gear in the LCRRA but based on takes in analogous commercial fisheries, the LOA application estimates that one each of California sea lion, Steller sea lion (Eastern DPS), and harbor seal may be taken in trawl gear and one each of these three species may be taken in purse seine or tangle net gear during the 5-year authorization period in the LCRRA . If this level of take actually occurred, it would be less than one percent of PBR for all three species and would be considered minor in magnitude (Table 4.2-16). The overall impact of the potential takes of these species in the LCRRA would be considered minor adverse under the Preferred Alternative according to the criteria described in Table 4.1-1.

The only trawl used in the LCRRA is an open-ended (no bag or cod-end) pair trawl used in the Pair Trawl Columbia River Juvenile Salmon Survey. The trawl is not towed, but is held open in place. Additional mitigation measures proposed under the Preferred Alternative include testing the potential to replace the pair trawl net used in this survey with a flexible towed matrix of large coiled antennas for PIT-tag detection. Doing so should eliminate the potential for marine mammal interactions and the need to employ deterrence techniques. Mitigation measures are described in Section 2.2.1 and 2.3.1.

4.3.4.4 Conclusion

Under the Preferred Alternative, potential direct and indirect effects on marine mammals through acoustic disturbance, potential changes in prey availability, and contamination or degradation of habitat would be similar to those described for the Status Quo Alternative (Section 4.2.4) and would be considered minor adverse for all species.

The numbers of marine mammals estimated to be taken in future NWFSC-affiliated research under the Preferred Alternative are based on the historical takes of at least one species of cetacean (Pacific white-sided dolphins plus unidentified porpoise/dolphins) and four pinniped species (Steller sea lion, California sea lion, northern fur seal, and harbor seal) during NWFSC research surveys from 1999 through 2014. All takes, except for a single harbor seal released alive in Puget Sound, were in the CCRA, and all involved surface trawls. Available historic data and other data on mortalities in commercial fisheries using similar gear were used to estimate the potential for combined level A harassment takes and serious injuries and mortalities under the Preferred Alternative. The Preferred Alternative also includes a suite of mitigation measures currently implemented for NWFSC surveys under the Status Quo Alternative and several new training, communication, and mitigation programs intended to improve the effectiveness of the existing mitigation measures used to protect marine mammals and other protected species. New measures proposed under the Preferred Alternative should help reduce impacts relative to the Status Quo Alternative. Future takes, if they occur, would likely be fewer than the estimated numbers since estimates are based on a conservative approach to ensure accounting for a precautionary level of potential take. The estimated potential takes in all research gears and in all research areas would be below 10 percent of PBR for most species/stocks and would be considered to have minor magnitudes of effect on the population level for each of the impacted species. Using a “worst case” analysis, estimated takes, if they occurred, could account for between 10 percent and 50 percent of PBR for two stocks of bottlenose dolphin and would be considered moderate in magnitude. Adverse interactions with research gear would likely continue to occur infrequently and would likely be dispersed over time and space throughout the areas within which NWFSC conducts fisheries research, particularly in the CCRA. The impact of these potential takes, if they occurred, would be considered minor adverse for all species.

The overall effects of the Preferred Alternative on marine mammals would be minor in magnitude, dispersed over a large geographic area, and temporary or short-term in duration, and would therefore be considered minor adverse according to the impact criteria in Table 4.1-1.

Table 4.2-10 and Figure 4.2-1 show historical takes of pinnipeds by all NWFSC research activities. All takes were in surface trawls. The only take in the PSRA was of a single harbor seal in 2009 during the Skagit Bay Juvenile Salmon Survey. Trawling was stopped when the crew noticed harbor seal activity adjacent to the net, the net was retrieved and the seal was released alive. Measures to mitigate the risk of entanglements are described in Sections 2.2.1 and 2.3.1.

4.3.5 Effects on Birds

The effects of the Preferred Alternative on birds would be very similar to those described for the Status Quo (Section 4.2.5). Several surveys conducted under the Status Quo Alternative would not be conducted under the Preferred Alternative, and several new surveys would be added (Table 2-3-1). There would be some minor differences in the gear types used and research effort in the NWFSC research areas but the one survey with historical interactions with seabirds, the PNW Juvenile Salmon Survey, would remain unchanged. The expected amount of incidental seabird takes would therefore be the same as described for the Status Quo Alternative.

4.3.5.1 Conclusion

The effects of NWFSC fisheries research on seabirds include the potential for injury and mortality in fishing gear and ship strikes, changes in food availability, and contamination or degradation of habitat. Incidental captures of seabirds in NWFSC research gear have occurred infrequently in the CCRA but not in the PSRA or LCRRA and the magnitude of these takes are considered minor under the Preferred Alternative. The overall risk of NWFSC fisheries research causing changes in food availability for seabirds or contamination in the marine environment detrimental to seabirds is considered minor adverse.

The overall effects on seabirds from NWFSC research activities under the Preferred Alternative would likely be minor in magnitude, dispersed over a large geographic area, and temporary or short-term in duration and would therefore be considered minor adverse according to the criteria in Table 4.1-1. This conclusion holds for each of the three NWFSC research areas and for all gear types used in research.

4.3.6 Effects on Sea Turtles

The effects of the Preferred Alternative on sea would be very similar to those described for the Status Quo Alternative (Section 4.2.6). Direct and indirect effects of NWFSC research activities on sea turtles may include: disturbances or changes in sea turtle behavior due to physical movements and sounds, injury or mortality due to ship strikes, entanglement in gear, and contamination or degradation of sea turtle habitat. These mechanisms are described in Section 4.2.6.

Mitigation measures for protected species proposed under the Preferred Alternative, such as increased protected species training and reporting requirements and the use of marine mammal excluder devices on the Nordic 264 trawl, could potentially decrease the likelihood of adverse impacts to sea turtles. However, because no adverse interactions have occurred in the past between sea turtles and NWFSC research surveys, the expected reduction in potentially adverse impacts to sea turtles would be minimal.

4.3.6.1 Conclusion

NWFSC fisheries research activities conducted under the Preferred Alternative would involve a relatively small number of research vessels, short deployments of fishing gear, and sample sites dispersed over a wide area. Behavioral disturbances of sea turtles from research vessels or fishing gear would be temporary in nature, lasting only a few minutes as the research vessel passes, and are therefore likely to have negligible effects on turtle foraging success or survival. There have been no gear interactions with sea turtles and NWFSC research activities in the past so the potential for injury or mortality under the Preferred Alternative is very small. The potential for research vessels to degrade turtle habitat through

benthic disturbance, changes in prey availability, or contamination from accidental spills and discharges would likely be minor in magnitude, infrequent or rare, and localized.

The overall effects of the Preferred Alternative on ESA-listed sea turtles would likely be small in magnitude, dispersed over a large geographic area, and temporary or short-term in duration and would therefore be considered minor adverse on all species of sea turtles according to the criteria in Table 4.1-1.

4.3.7 Effects on Invertebrates

NWFSC-affiliated fisheries research conducted under the Preferred Alternative would have the same types of effects on invertebrate species as described for the Status Quo Alternative (Section 4.2.7) through mortality, physical damage, changes in species composition, and degradation of habitat. Several projects either add or subtract video camera equipment, scuba divers, or other minor gears that would not affect the catch of invertebrates. None of the differences between the Preferred Alternative and the Status Quo Alternative would substantially change the potential impacts of research on benthic habitat or the risk of accidental contamination and would not substantially change the amounts of invertebrates caught in research gear.

4.3.7.1 Conclusion

All of the potential effects on invertebrates were considered minor adverse under the Status Quo Alternative (Section 4.2.3) and would also be considered minor adverse under the Preferred Alternative for the same reasons. The overall effects of the Preferred Alternative on invertebrates would likely be low in magnitude, distributed over a wide geographic area, and temporary or short-term in duration and would therefore be considered minor adverse according to the criteria in Table 4.1-1.

The Preferred Alternative would also contribute to long-term beneficial effects on managed invertebrate species throughout the West Coast Region through the contribution of NWFSC fisheries research to sustainable fisheries management. Data from NWFSC-affiliated research provides the scientific basis to reduce bycatch, establish optimal fishing levels, prevent overfishing, and recover overfished stocks. The beneficial effects of the time-series data provided by NWFSC research programs are especially valuable for long-term trend analysis for commercially harvested invertebrates and, combined with other oceanographic data collected during fisheries research, provide the basis for monitoring changes to the marine environment important to invertebrate populations.

4.3.8 Effects on the Social and Economic Environment

The NWFSC fisheries research program under the Preferred Alternative includes the addition or modification of several long-term surveys and the discontinuation of several long-term surveys conducted under the Status Quo Alternative. These differences under the Preferred Alternative are not expected to measurably increase or decrease socioeconomic effects compared to the Status Quo Alternative (see Section 4.3.8).

NWFSC-affiliated fisheries and ecosystem research conducted under the Preferred Alternative would provide a rigorous scientific basis for fisheries managers to set optimum yield fishery harvests, assist in the recovery of overfished and ESA-listed species and ultimately rebuilding these stocks to appropriate levels, and contribute to the protection of tribal fishery resources. It would also contribute directly and indirectly to local economies, promote collaboration and positive relationships between NMFS and tribal co-managers as well as with commercial and recreational fishing interests, and help fulfill NMFS obligations to communities under U.S. laws and international treaties.

4.3.8.1 Conclusion

The direct and indirect effects of the Preferred Alternative on the social and economic environment would be certain to occur, minor to moderate in magnitude depending on the community, long-term, and would be felt throughout the West Coast region. According to the impact criteria established in Table 4.1-1, the direct and indirect effects of the Preferred Alternative on the social and economic environment would be minor to moderate and beneficial.

4.4 DIRECT AND INDIRECT EFFECTS OF ALTERNATIVE 3 – MODIFIED RESEARCH ALTERNATIVE

This section presents an analysis of the potential direct and indirect effects of Alternative 3 – Additional Mitigation Alternative on the physical, biological, and social environment. Under this Alternative, the NWFSC would conduct a new suite of research activities and implement new mitigation measures in addition to the Status Quo program. The new suite of research activities is a combination of past research and additional, new research, as described for the Preferred Alternative. Potential direct and indirect effects were evaluated according to the criteria described in Table 4.1-1. A summary of the impact rating determinations for all topics evaluated under Alternative 3 is presented below in Table 4.4-1.

Table 4.4-1 Alternative 3 Summary of Effects

Resource	Physical Environment	Special Resource Areas	Fish	Marine Mammals	Birds	Sea Turtles	Invertebrates	Social and Economic
Section #	4.4.1	4.4.2	4.4.3	4.4.4	4.4.5	4.4.6	4.4.7	4.4.8
Effects Conclusion	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor to Moderate <i>beneficial</i>

4.4.1 Effects on the Physical Environment

The effects of the Modified Research Alternative on the physical environment would be similar to those of the Status Quo Alternative (see Section 4.2.1). Additional mitigation measures for protected species required under the Modified Research Alternative would not change the effects of the research activities on physical properties of the environment with the potential exception of the spatial/temporal restrictions on NWFSC research activities intended to reduce adverse impacts to protected species. This type of mitigation measure could potentially reduce the overall level of research effort somewhat or alter where and when that research occurred. However, specific restrictions have not been proposed and the overall effects on the physical environment are assumed to be essentially the same as those described under the Status Quo Alternative. Therefore, the overall effects of the Modified Research Alternative on the physical environment would be minor in magnitude, dispersed over a large geographic area, and temporary or short-term in duration, and would therefore be considered minor adverse according to the impact criteria in Table 4.1-1.

4.4.2 Effects on Special Resource Areas

The effects of the Modified Research Alternative on special resource areas would be similar to those of the Status Quo Alternative (see Section 4.2.2). Most of the additional mitigation measures for protected species proposed under the Modified Research Alternative would not change the effects of the research activities on the physical components of the environment or on most biological components; they would only tend to decrease effects on protected species, which were considered minor under the Status Quo. The exception is the potential for spatial/temporal restrictions on NWFSC research activities intended to reduce adverse impacts on protected species. These restrictions could be placed on particular gear types of concern or in particular areas of concern such as federal and state MPAs. An MPA is defined by Executive Order 13158 as “any area of the marine environment that has been reserved by federal, state, tribal, territorial, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein.” They include: state MPAs, National Wildlife Refuges, National Park Service MPAs, and National Marine Sanctuaries (see Section 3.1.2.4). Executive Order 13158 also includes the following directive: “To the extent permitted by law and to the maximum extent practicable, each federal

agency, in taking such actions, shall avoid harm to the natural and cultural resources that are protected by an MPA.”

MPAs within the NWFSC fisheries research area include five West Coast National Marine Sanctuaries, areas closed to certain fishing gears (e.g., EFH Closed Areas and the Cowcod Conservation Area), and numerous smaller protected areas (NOAA 2010d). Some MPAs have permit systems for activities that would otherwise be prohibited, such as scientific research with bottom trawl gear, and the NWFSC applies for such permits if a particular research activity may adversely affect the MPA. These permits may restrict the level of effort, gear types used, locations, and other conditions of the activity as well as having monitoring and reporting requirements. The Status Quo therefore already includes the potential prohibition or restriction of NWFSC research activities in MPAs. Any spatial/temporal restrictions on NWFSC fisheries research in MPAs (or other designated areas) under the Modified Research Alternative would decrease or minimize the potential for direct adverse impacts to special resource areas relative to the Status Quo Alternative, for which effects were considered minor adverse.

MPAs are, by definition, managed more carefully than other areas and depend on scientific data to monitor the status of the habitats and resources they are designed to protect. As was the case for the Status Quo Alternative, the scientific data generated from NWFSC research activities under the Modified Research Alternative could have beneficial effects on special resource areas, including National Marine Sanctuaries, through their contribution to science-based conservation management practices. This is why many MPAs include exemptions or permit processes for scientific research. Indirect effects resulting from spatial/temporal restrictions on research in MPAs could include adverse impacts resulting from a lack of the data needed to support science-based management of MPAs. The magnitude and duration of the indirect adverse effects would depend on how extensive the restrictions on research became and how long such restrictions lasted.

Specific spatial/temporal restrictions on NWFSC research have not been proposed under the Modified Research Alternative; the overall level of research effort and therefore effects on the marine environment are assumed to be essentially the same as those described under the Status Quo Alternative. Therefore, the overall effects of the Modified Research Alternative on special resource areas would be minor in magnitude, dispersed over a large geographic area, and temporary or short-term in duration, and would be considered minor adverse according to the impact criteria in Table 4.1-1.

4.4.3 Effects on Fish

Under the Modified Research Alternative, the NWFSC would implement additional mitigation measures for protected species while conducting the same scope of research as described under the Preferred Alternative. Most of the additional mitigation measures would be unlikely to affect the amount of fish caught for research purposes or potential impacts on habitat. The exceptions are the potential for spatial/temporal restrictions on NWFSC-affiliated research in areas considered important to protected species and the potential for incorporation of marine mammal or sea turtle excluder devices in research trawls.

Spatial/temporal restrictions could reduce research fishing and hence impacts on fish in some locations. However, researchers may respond to spatial/temporal restrictions by redirecting research efforts to other locations if such movements are consistent with research goals and do not compromise time-series data sets. If so, overall research efforts could remain the same. The Modified Research Alternative does not specify particular spatial/temporal restrictions but it is assumed for the DPEA analysis that overall research effort and therefore impacts to fish would be very similar under the Modified Research Alternative as they are for the Preferred Alternative, although they may occur in somewhat different locations and times.

The NWFSC has recently incorporated a marine mammal excluder device in the Nordic 264 surface trawl but not in other types of trawls. The incorporation of marine mammal or sea turtle excluder devices in other research trawls could affect the numbers, species, and size/age classes of fish caught in the trawls. These potential changes in the catchability of research trawls would have critical implications for the scientific validity of the research and could compromise the integrity of time-series data used to inform fisheries stock assessments. Any such gear changes would require extensive and expensive testing and calibration studies across the range of habitats, depths, spatial areas, and seasons of the survey to test potential impacts under all survey conditions before they could be implemented. For this reason, the NWFSC is not proposing to add additional excluder devices or other gear modifications to its research protocols under the Preferred Alternative. It is not possible to estimate what the effects may be for any species of fish if such changes were mandated under the Modified Research Alternative.

It is assumed for this DPEA analysis that overall impacts to fish under the Modified Research Alternative would be substantially the same as those described under the Preferred Alternative. These effects would be low in magnitude, distributed over a wide geographic area, and temporary or short-term in duration and would therefore be considered minor adverse according to the criteria in Table 4.1-1. As was the case with the Status Quo and Preferred Alternatives, the Modified Research Alternative would also contribute to long-term beneficial effects on managed fish species throughout the West Coast Region through the contribution of NWFSC-affiliated fisheries research to sustainable fisheries management.

4.4.4 Effects on Marine Mammals

The Modified Research Alternative includes the same scope of research in all three NWFSC research areas as the Preferred Alternative, including the same mitigation measures currently implemented or to be implemented, and intended to reduce potentially adverse interactions with marine mammals and other protected species. The Modified Research Alternative differs from the Preferred Alternative in that it also includes a suite of mitigation measures that the NWFSC is not proposing to implement as part of the proposed action in the NWFSC LOA application (Appendix C). The NWFSC considers the suite of mitigation measures to be implemented under the Preferred Alternative to represent the most effective and practicable means to reduce the risk of adverse interactions with protected species without adversely affecting the scientific integrity of its research programs. However, NMFS's Office of Protected Resources (OPR) must consider a broad range of mitigation measures under the MMPA authorization and ESA consultation processes, and these additional measures will be considered in this alternative. These additional mitigation measures focus on reducing the likelihood of mortality or injury from interaction with fisheries research gear (Level A harassment and serious injury and mortality take), particularly trawl and hook-and-line gear, and are described in Section 2.4 of this DPEA. They involve:

- The use of additional personnel and equipment/technologies to improve detection of marine mammals, especially at night or other low-visibility conditions.
- Modification of the move-on rule to require a 30 minute monitoring period before deployment of trawl gear.
- Operational restrictions on survey activities at night or other low-visibility conditions.
- The use of additional acoustic or visual deterrents to keep marine mammals away from research gear.
- Gear modifications, including marine mammal excluder devices on trawl nets (in addition to the Nordic 264 surface trawl)
- Temporal or geographic restrictions to avoid known concentrations of marine mammals or federal and state MPAs.

- Use of decoy vessels to distract marine mammals away from research sets.

None of the additional mitigation measures directly concern the reduction of noise from vessels or acoustic devices (Level B harassment take), reducing the numbers of fish and invertebrates caught in research samples, or reducing the risk of accidental contamination from spills. The analyses of effects through these mechanisms (disturbance or changes in habitat quality) are the same as described for the Status Quo and Preferred Alternatives and will not be discussed further. The following analysis will therefore focus on the potential for the additional mitigation measures to reduce the risk of Level A harassment, injury, and mortality through entanglement in fishing gear or ship strikes.

Scientists at the NWFSC continually review their procedures to see if they can do their work more efficiently and with fewer incidental effects on the marine environment, including effects on marine mammals. Many of the additional mitigation measures included in this alternative have been discussed and considered in the past by NWFSC scientists; however, any changes to operational procedures or the equipment used during surveys must also be considered from the standpoint of how they affect the integrity of the scientific data collected, the cost of implementing equipment or operational changes, and the safety of the vessel and crew. It is not possible at this time to quantify how much any one of these measures (or some combination of them) may reduce the risk of future takes relative to the Status Quo or Preferred Alternatives. Any revisions to the estimated takes of each species to directly compare with the Status Quo or Preferred Alternatives would be based on speculation. This analysis will therefore provide a qualitative discussion of the potential for each additional mitigation measure to reduce takes and other effects on marine mammals as well as how each measure may affect practicability, data integrity, and other aspects of the survey work.

4.4.4.1 Trawl Surveys

Several NWFSC surveys use bottom, midwater, and surface trawl gear (see Tables 4.2-1 and 4.3-1). The following mitigation measures would apply to all trawl gear, even though marine mammal takes between 1999 and 2014 occurred only in surface trawls.

Monitoring Methods

Visual observations (using bridge binoculars as needed) by the officer on watch, Chief Scientist (CS) or other designated scientist, and crew standing watch are currently the primary means of detecting protected species in order to avoid potentially adverse interactions. However, there are other detection methods that have been tested or used in commercial fisheries, naval exercises, and geotechnical exploration that could be considered. These additional types of detection methods would be intended to be used in specific circumstances, such as operating at night or in low visibility conditions.

Visual surveillance by dedicated Protected Species Observers (PSO)

This measure would require the NWFSC to use trained protected species observers whose dedicated job is to detect the presence of marine mammals and other protected species within the survey area and communicate their presence to ship operations personnel. Considerations include the use of dedicated observers for all surveys or during trawl surveys of particular concern.

Under the Status Quo Alternative, the officer on watch (or other designated member of the scientific party), and crew standing watch on the bridge visually scan for marine mammals (and other protected species) during all daytime operations. Bridge binoculars are used as necessary to survey the area upon arrival at the station, during reconnaissance of the trawl line to look for potential hazards (e.g., presence of commercial fishing gear, sonar sweeps to check if bottom topography is suitable for trawling, etc.), and while the gear is deployed. If any marine mammals are sighted by the bridge or deck crew prior to or after setting the gear, the bridge crew and/or Chief Scientist are alerted as soon as possible. Currently, not all

crew members have received formal training in marine mammal identification or marine mammal mitigation procedures, although they are briefed on what they are looking for and may have considerable experience with the task. However, the Preferred Alternative does include a new program to refine and formalize the training and decision-making process for all Chief Scientists, bridge crew, and deck crew that may be assigned to the observer post in the future. This new program would provide similar types of training for all appropriate crew members as PSOs trained for that specific task. This training would be in conjunction with the NWFOP staff at NMFS using similar course materials and reporting forms as used to train PSOs for applicable commercial fisheries. The difficulty in having crew members assigned only to PSO duties is that most vessels have limited carrying capacity for personnel and any berths given to PSOs would mean a reduction in personnel available to help with other research or vessel duties. This could compromise crew safety or the amount of research that could be conducted. For research projects using contracted commercial fishing vessels, there is often no additional space on the vessels for personnel other than essential crew. By providing formal protected species training for crew already trained in other skills, the NWFSC believes it can provide the same quality of visual monitoring for marine mammals and other protected species as would occur with dedicated PSOs while maintaining the flexibility to fulfill all other crew duties.

Use of underwater video systems to monitor trawl gear

Underwater video technology may allow the NWFSC to determine the frequency of marine mammal interactions with the trawl gear and evaluate the effectiveness of MMEDs or other efforts to mitigate entanglement interactions. Underwater video systems have been used for these purposes in several fisheries, both in the U.S. and abroad (Northridge 2003, Lyle and Willcox 2008, Dotson et al. 2010). Northridge (2003) describes a twin camera system used to monitor the grid and escape hole of an MMED and quantify the frequency and outcome of marine mammal interactions with trawl gear. Video images were carried by cable from the cameras to the wheelhouse for continuous display and recording (Northridge 2003). Similarly, Lyle and Willcox (2008) used a low-light black and white digital camera with a 90 degree wide-angle lens coupled to a commercially available hard drive unit to monitor interactions involving marine mammals and other megafauna.

Underwater video equipment may provide useful information about the efficacy of additional mitigation measures but the video equipment itself is unlikely to influence bycatch rates of protected species. In order to directly reduce takes of marine mammals, a video system to detect marine mammals underwater would have to be linked to a means of avoiding entanglement in gear. However, ships with deployed trawl nets cannot “swerve” to avoid a marine mammal for two reasons: 1) all marine mammals can swim faster than the tow speed so trying to move gear away from an animal that is likely attracted to fish in the net will be ineffective, and 2) changing the vessel direction suddenly risks tangling the gear, making it difficult and dangerous to retrieve, delaying retrieval and making the risk of marine mammal entanglement worse.

Use of passive acoustic monitoring

Passive acoustic monitoring involves the detection of animals by listening for the sounds that they produce (Barlow and Gisiner 2006). Use of passive acoustic monitoring may aid in the detection of marine mammals present in survey areas, and could potentially be used to inform decisions about when to implement appropriate modifications of fishing operations to prevent interactions with marine mammals. Marine mammal calls can be reliably detected using hydrophones mounted on ships, autonomous underwater gliders, buoys, moorings, or bottom-founded installations. However, not all marine mammals vocalize and the vocalization rates of marine mammals may vary in a complex fashion depending upon environmental factors, including long periods of silence (Barlow and Gisiner 2006). While detection of a marine mammal call indicates the presence of a marine mammal, the absence of marine mammal calls does not necessarily indicate the absence of marine mammals. In addition, if the intent is to locate marine

mammals so that they can be avoided, hydrophones in multiple locations combined with real-time processing are required to allow triangulation of the acoustic signal. This may be more practicable for planning large-scale activities at a set time and place rather than directing specific locations for research sampling, which involves continuous movement of a vessel from widely spaced sampling stations. Taking the time to set up a triangulated hydrophone system in an area prior to each 20 minute trawl would greatly lengthen the time and cost of collecting a certain amount of sample data. In summary, passive acoustic monitoring may be useful for detecting underwater marine mammals that could potentially interact with research activities but it would have substantial costs in terms of the research data collected and it would not guarantee the avoidance of all adverse interactions; passive acoustic monitoring inevitably overlooks those marine mammals that are not vocalizing and marine mammals may move into an area after trawl gear is deployed and still be at risk.

Use of aircraft or unmanned aerial or underwater gliders to expand detection of marine mammals

Currently, surveys using manned aircraft are routinely conducted to obtain unbiased estimates of marine mammal populations and their distributions. Aerial surveys provide reliable information about marine mammal populations because they are able to cover large areas over relatively short periods of time. In addition, airborne survey platforms generally do not influence the distribution or behavior of the marine mammals being counted, whereas many species of marine mammals are either attracted to or avoid seagoing vessels (Barlow and Gisiner 2006). The usefulness of manned aerial surveys for detection of marine mammals that could interact with fisheries research activities is limited by the range that the aircraft may travel from shore, flight time constraints, weather conditions, poor visibility in rough seas, logistical difficulties in matching a fast-moving airplane with a slow-moving research vessel, and considerable expense that would likely decrease the amount of ship-based research that could be conducted. Aerial surveys may be more practicable for planning large-scale activities at a set time and place rather than directing specific locations for research sampling, which involves continuous movement of a vessel from widely spaced sampling stations. Even with this capacity, the risk of marine mammal interactions would remain because any marine mammals that are not near the surface would not be detectable by airborne observers and, as with other extended detection methods, marine mammals may move into an area after trawl gear is deployed but before it is retrieved.

Unmanned aerial vehicles have the potential to overcome many of the limitations associated with manned aerial surveys for detection of marine mammals. Unmanned aerial systems range from inexpensive lightweight radio-controlled aircraft to complex autonomous aircraft developed for military applications. Unmanned aerial systems could be launched and retrieved from the research vessel, stream video data to observers onboard or at a shore station, and provide near-real-time data of marine mammals in proximity to fisheries research activities. Several systems are commercially available that have the ability to remain airborne for up to 24 hours and can be operated up to 93 miles from the control station. Several tests have successfully used unmanned aerial vehicles for marine mammal detection (NOAA 2006). However, these systems can only be operated in mild to moderate wind conditions, with increasing wind speeds strongly reducing their range and making recovery difficult.

Advantages associated with the use of unmanned aerial systems include the ability to operate in areas far from shore, long flight times, increased safety of observers who can monitor the data from the ship or a shore based location, and decreased expense relative to surveillance conducted from manned aircraft. Unmanned aerial technologies are rapidly evolving; over the next five to 10 years, increased video resolution and advanced sensors are likely to increase the utility of these systems for monitoring marine mammals. However, approval from additional regulatory agencies, including the Federal Aviation Administration, would be required for operation of unmanned aerial vehicles for marine mammal monitoring or research purposes. Federal Aviation Administration approval has been very difficult to obtain, even in areas with very little air traffic, which currently limits the potential for using these systems over large areas.

Autonomous underwater gliders are highly successful platforms for the collection of oceanographic data and environmental characterization. Gliders offer an attractive platform for marine mammal detection due to their relatively low cost, low power consumption, and the ability to cover large areas of ocean during long-term deployments (Olmstead et al. 2010). Gliders have been used to locate and identify marine mammals using passive acoustic technology, and the U.S. Navy is conducting additional research and development using autonomous underwater gliders to support efforts to mitigate impacts from marine mammal interactions (Hildebrand et al. 2009). The use of underwater gliders to provide mitigation options for research activities is limited by the same issues as described above for other passive acoustic detection systems.

Use of infrared technologies

Infrared (IR) sensors may be useful for detection of marine mammals under certain circumstances. IR sensors used for marine mammal detection generally measure the spatial distribution of mid-wavelength IR radiation (three to five micrometers). IR emissivity of an object in this waveband is closely correlated to the object's surface temperature, such that IR sensor arrays can detect slight variations in temperature across relatively large areas. This technology, also known as 'thermal imaging', could be useful to augment visual detection of marine mammals, particularly in conditions with low ambient light when visual detection of marine mammals would be difficult. IR image data also lends itself to automated image processing. With additional research and development, it is possible that an automated marine mammal detector could be designed to recognize the IR 'signatures' of certain marine mammals. However, several major drawbacks currently preclude such use of IR detection for automated marine mammal detection.

First, because emitted IR radiation is absorbed in the first few millimeters of water surrounding an object, IR technology is only able to detect animals at the surface, and only those parts that are above the surface of the water. Since water is virtually opaque to IR radiation, IR detection of marine mammals is also complicated by the thin film of water that covers the dorsal surfaces of marine mammals at the sea surface. The temperature measured by an IR sensor is the temperature of the water on the surface of the animal, which may only be a couple degrees above the surface water temperature (Cuyler et al. 1992, Kasting et al. 1989). Under ideal conditions (flat calm seas and close proximity to the IR detector), this slight temperature difference can be detected. However, waves cause the measured temperature of the sea surface to be much more variable and the thermal signature of the animal can easily be masked (Graber et al. 2011).

Second, the likelihood of detecting a temperature signature from a marine mammal falls off quickly with distance from the detector. In tests under ideal conditions, the ability of an IR system to detect killer whales, which present a large portion of their body and a tall dorsal fin above the surface of the water, was very poor beyond 330 feet (Graber et al. 2011). The ability of an IR system to detect much smaller targets like dolphins and porpoises would presumably be much less than it is for killer whales. Finally, considerable effort and time is required to process the video data so that the thermal signatures of animals can be distinguished from the surrounding water. This greatly reduces the effectiveness of the technique for real-time monitoring tied to potential mitigation. In summary, the logistical difficulties of using IR detectors in a real-life context on a research vessel would be overwhelming and currently preclude this potential tool as a practical element of mitigation.

Use of night vision devices

Like IR imaging devices, night vision devices may be used for detecting marine mammals at or above the water surface in low-light conditions. Unlike IR sensors, night vision devices operate by amplifying the signal produced when visible light interacts with a detector. Although night vision devices could potentially improve an observer's ability to detect a marine mammal under low light conditions, previous

studies have shown that the effective range of detection for marine mammals using night vision devices is only about 330 feet (Calambokidis and Chandler 2000, Barlow and Gisner 2006). These devices work best when there is a little light on the water (from the moon or nearby land sources) but they must be directed away from deck lights because they are too bright. This means they could not be used to monitor trawl gear as it is being deployed or retrieved because of the deck lights used for crew safety. They also have a very narrow field of view, making broad area searches inefficient and unreliable, and if sea conditions are rough the many reflections off waves make it very difficult to distinguish objects in the water. Some observers found the devices disorienting and uncomfortable and all observers said it was very difficult to estimate distances while using the night vision devices (Calambokidis and Chandler 2000). Failure to detect marine mammals using such devices would not decrease the uncertainty about whether marine mammals are actually in the immediate area or not and would thus offer no help in deciding whether to deploy trawl gear or not.

Operational Restrictions

The modification of the move-on rule to require a 30-minute monitoring period for all trawl surveys would effectively change protocols for surveys using mid-water and bottom trawls, which currently employ a minimum 10-minute monitoring period, although that period may be extended if other sampling or reconnaissance activities take place once the vessel arrives on station. This 30-minute monitoring period requirement is effectively what occurs under the Status Quo Conditions for the Juvenile Salmon PNW Coastal Survey, the survey that uses the Nordic 264 surface trawl and is responsible for most of the past marine mammal takes in NWFSC research gear. As described in Section 2.2.2.2, monitoring for marine mammals on this survey involves three to eight people beginning about 10 minutes before arrival on station and continuously during reconnaissance of the trawl line and deployment of bongo nets and CTDs. Monitoring continues while the trawl net is deployed and, by the time the trawl doors are deployed, a period of at least 30 minutes has typically elapsed. This requirement would therefore effectively only apply to non-surface trawl surveys.

This new protocol would be intended to improve the chances of seeing marine mammals present in the sampling area before gear was deployed, thus reducing the risk of incidental capture or entanglement in research gear. This measure is based on the fact that marine mammals typically spend most of their time under water and are difficult to see. Further, it is based on the premise that extending the monitoring period to allow them time to surface and be seen by ship-board observers improves the chances of avoiding adverse gear interactions. While this measure is reasonable from the perspective of observing marine mammals under good conditions, its effectiveness would vary considerably depending on lighting conditions and sea state, with essentially no potential for reducing interactions at night or other conditions of poor visibility, which occur frequently. In addition, the link between seeing marine mammals and reducing the risk of adverse gear interactions is dependent on some assumptions that may not be supported by the experience of NWFSC researchers. The measure assumes that visually spotting animals is directly correlated to gear interactions (i.e., animals are seen before they are caught and, conversely, animals are not caught when they were not seen previously). While NWFSC research activities have a small number of marine mammal interactions on which to base any conclusions, this assumption is not supported by experienced scientists from the NWFSC (Kurt Fresh, pers. comm.). Given the fact that the NWFSC has only had one incident of taking marine mammals in mid-water trawls (two California sea lions in one tow) and no historical takes in bottom trawl gear, there is even less experience on which to base an assessment of whether this extended monitoring period would decrease the risk of interactions with these gears.

Table 4.2-10 indicates the time of day when most of the past marine mammal gear takes have occurred during NWFSC research. At least half of the incidents occurred during daylight hours when animals could

presumably have been seen if they were at the surface. The type of marine mammals seen and their behavior in relation to the ship and gear are currently part of the ship-board judgment about whether any marine mammals present are in danger of interactions with research trawls. The NWFSC believes that adding a longer monitoring period in which no marine mammals could be seen before mid-water or bottom trawl gear is deployed would preempt the professional judgement of its scientists and ship crews in avoiding interactions and would not reduce the risk of incidentally taking marine mammals.

Another concern for the NWFSC is the potential for this mitigation measure to bias its data by forcing it to abandon sampling stations that are “hotspots” for marine life. Marine mammals and other predators are often drawn to areas and oceanic conditions where fish and invertebrate prey are concentrated. Region-wide, multi-species surveys such as the Juvenile Salmon PNW Coastal Survey and the Groundfish Bottom Trawl Survey are designed to assess the distribution and abundance of many species through randomized sampling of many dispersed sites. The validity of statistical methods used to expand sampling results into inferences about the range-wide population status of these species depends on the random sampling of “hotspots” as well as sites with lower densities of animals. If these surveys could not sample in areas rich in marine life, as indicated by the presence of marine mammals, even if the marine mammals did not appear to be at risk of interaction with the research gear, the sampling results would not accurately reflect the variability in abundance for different species and the ability of the NWFSC to provide the “best available” scientific data for fisheries management purposes would be compromised. This type of ecological information is also important to agencies and other institutions concerned about the health of the marine environment important to marine mammals themselves.

Another potential mitigation measure would require the NWFSC to suspend trawl operations at night or during periods of low visibility (including fog and high sea state) to minimize interactions with marine mammals that would be difficult to detect by visual monitoring. Since a portion of the marine mammal take in NWFSC research trawls occurred during dusk, hours of darkness, or in early morning conditions, this measure has the potential to reduce the risk of interactions with marine mammals. However, many takes occurred during daylight hours, including all of the takes since 2006 (Table 4.2-10), so restricting operations to only daylight hours would not eliminate the majority of risk. In addition, restrictions on trawling at night could seriously hinder the ability of the NWFSC to complete their sampling protocol. If survey vessels had to stand down when they encountered fog or rough seas, survey periods would have to be extended or fewer stations would have to be sampled to accommodate such delays. This would mean substantially higher costs and/or decreased quality of data. Although visual monitoring is a reasonable and practicable precaution to undertake for trawl surveys, it does not ensure that marine mammals will be detected or that entanglement can be prevented even if they are detected.

Acoustic and Visual Deterrents

The NWFSC currently deploys acoustic pingers on surface trawl nets, including those used in the Juvenile Salmon PNW Coastal Survey. This is the survey responsible for 33 of 42 takes since 1999, including six Pacific white-sided dolphins in one trawl in 2014 (Table 4.2-10). This measure would require the NWFSC to use additional acoustic deterrents on all trawl gear, including pingers and recordings of predator (e.g., killer whale) vocalizations to deter interactions with trawl gear. This measure would also require the NWFSC to use visual deterrence techniques (e.g., lights, light sticks, reflective twine/rope) to reduce marine mammal interactions with the gear.

Acoustic pingers have been shown to be effective in deterring some marine mammals, particularly harbor porpoises, from interacting with gillnet gear (Nowacek et al. 2007, Carretta and Barlow 2011). There are, however, few studies testing their efficacy when used with trawl gear and, based on recent takes by the NWFSC, efficacy with surface trawls is not 100 percent. Studies of acoustic deterrents in a trawl fishery in Australia concluded that pingers are not likely to be effective in deterring bottlenose dolphins, as they are already aware of the gear due to the noisy nature of the fishery (Stephenson and Wells 2008, Allen et

al. 2014). Acoustic deterrents were also ineffective in reducing bycatch of common dolphins in the U.K. bass pair trawl fishery (Mackay and Northridge 2006). Although acoustic deterrents may be effective in preventing bycatch in gillnets, their efficacy in preventing bycatch in trawl nets is currently uncertain. A primary reason for this is that the noise associated with trawl gear (chains, ropes, trawl doors) is sufficiently loud that any acoustic device used would have to be louder than that generated by the ship and fishing gear which could, in turn, cause auditory damage or exclusion of cetaceans from important habitat (Zollett 2005). Underwater broadcasting of pre-recorded predator sounds (e.g. killer whale calls) to scare animals away from the fishing operation has been suggested as a potential mitigation measure but Jefferson and Curry (1996) concluded that this technique was largely ineffective for reducing marine mammal interactions with commercial fisheries based on their review of multiple studies.

Several methods have been suggested to help protected species visually detect fishing gear and avoid entanglement. Increasing acoustic reflectivity of nets through the addition of materials such as barium sulphate or acoustic reflectors has been tested, with varying degrees of success, in several set-net fisheries (Mooney et al. 2004, Rowe 2007). The applicability and efficacy in trawl fisheries is currently unknown. Similarly, nets could be illuminated with phosphorescent or luminescent materials and, ultimately, reduce the potential for entanglement. Wang et al. (2013) tested the efficacy of illuminating nets used in a Mexican bottom set-net fishery with ultraviolet (UV) light-emitting diodes to reduce sea turtle bycatch. UV net illumination significantly reduced green sea turtle bycatch without impacting target fish catch rates. Applicability in trawl fisheries and efficacy in deterring marine mammals with similar technology are, however, currently unknown.

Gear Modifications

Under the Preferred Alternative, NWFSC would include a marine mammal excluder device on the Nordic 264 surface trawls used in the Juvenile Salmon PNW Coastal Survey (Section 2.3.1). Excluder devices would be required on additional trawl nets under the Modified Research Alternative. Marine mammal excluder devices have been developed for several types of trawl nets and at least one device is being used by the Southwest Fisheries Science Center (SWFSC) during fisheries research with the Nordic 264 trawl. In addition, the SWFSC is developing a marine mammal excluder device for the modified Cobb midwater trawl (SWFSC 2013). These devices are similar to turtle excluder devices and are designed to allow fish to pass through the bars of the excluder while marine mammals are guided to an escape hatch built into the net. The challenge with developing an excluder device is to minimize the impact on the fishing performance of the net while effectively reducing captures of marine mammals in the net. The shape, size, design, and positioning of an excluder device in the net can substantially impact the fishing performance of the net (Dotson et al. 2010).

An important factor to consider when developing excluder devices or any other gear modifications is to determine how the device or gear modification impacts the scientific objectives of the research. In the case of the SWFSC survey that now uses a marine mammal excluder device on the Nordic 264 trawl, the relevant objective of the survey is to collect a sample of individual fish for a variety of measurements and to examine their reproductive status. The reduced efficiency of the modified net in catching fish therefore does not substantially interfere with the scientific objective of the research. However, the scientific objective of the NWFSC surveys using trawl gear is to estimate overall population abundance and distribution of numerous species across large geographic areas. Reductions in catchability of one or more fish species or size classes of fish, or increasing the variability of catch rates under different ocean conditions, could compromise the validity of the research survey and disrupt time-series data sets used to inform stock assessments. Given the value of these long time-series data sets for tracking ecosystem changes and the potentially huge economic implications for fisheries management of highly valuable commercial fisheries, any potential changes to research gear or protocols that may introduce uncertainty and bias into survey results must be thoroughly examined and planned years in advance of their implementation.

The NWFSC tested the net/excluder device and configuration used by the SWFSC on the Nordic 264 surface trawl and found that it caused a significant loss of some salmon species that were the target of the research (NWFSC, in preparation). Recent experiments in 2014 used video cameras attached to the nets to test different configurations of the excluder device to minimize loss of target species. Additional research will be necessary to calibrate catch levels in tows with the excluder device compared to past tows that did not contain the excluder (i.e., to align the new catchability rates with historical data sets). During these configuration and calibration experiments some nets will be fished without the excluder device in order to provide controls for catchability. Once the NWFSC completes these experiments the excluder device will be used in all future trawls with this net. This development work and incorporation of the excluder device into the Nordic 264 is included as part of the Preferred Alternative.

The NWFSC has not attempted to develop marine mammal excluder devices for any of the bottom or mid-water trawls it uses for research. There have been no historical captures of marine mammals in NWFSC bottom trawls and only one instance where two California sea lions were caught in a modified Cobb mid-water trawl during NWFSC research. As mentioned above, the SWFSC is developing an excluder device for the modified Cobb trawl but even if that effort is successful, it may not be directly transferable to the NWFSC research using that net for similar reasons as the Nordic 264 excluder, namely different research purposes and protocols. Such efforts to design and test potential excluder devices for specific nets and survey objectives require substantial efforts and expense. Given the small number of takes of marine mammals with these trawl types during NWFSC fisheries research, the scientific uncertainties it could introduce into the time-series data, and the economic cost of conducting calibration experiments to validate such gear modifications, the NWFSC is not proposing to conduct such gear modification research on these other nets in the near future.

Temporal or Geographic Restrictions

Spatial/temporal restrictions can be a direct way of reducing adverse impacts to protected species if there are known overlaps in time and space of the survey's footprint with concentrations of protected species. This measure would require the NWFSC to identify areas and times that are most likely to result in adverse interactions with marine mammals (e.g., areas of peak abundance) and to avoid, postpone, or limit their research activity to minimize the risk of such interactions with marine mammals. This may include limits on specific locations, physical or oceanographic features, biologically important times, and/or gear types.

While the rationale for such restrictions is clear, the methods for identifying appropriate places and times for effective restrictions are not. The Southwest Fisheries Science Center has been conducting marine mammal surveys along the West Coast for many years to monitor the changing patterns of marine mammal abundance and distribution. These patterns of abundance are dynamic and often correlated to particular oceanographic conditions, which vary among seasons and years, so marine mammal survey information from the previous year or even the previous month may not reflect actual conditions when it is time to deploy trawl gear. It might be possible to conduct aerial surveys or passive acoustic surveys in an area prior to conducting trawls, but such surveys require time to process data before actual density information is available.

Assuming recent marine mammal survey data are available for delimiting time or area restrictions, questions remain about what standards of density should be used for limiting research. This is important to the potential effectiveness of such restrictions because it is not clear if marine mammal density is a key factor in the risk of catching animals in a research trawl. Marine mammals can all swim much faster than an active trawl tow (two to four knots) so they can easily avoid such gear if they perceive it and choose to move. This is true no matter how many animals are in a given area. The risk of entanglement is likely influenced much more by the attraction of marine mammals to fish caught in the trawl or disturbed by it as the trawl passes by, which in turn may be influenced by the overall availability of prey and the

nutritional status of the marine mammals. Even if there are only a few marine mammals in an area, the risk of entanglement could be high if they are very hungry and strongly attracted to fish in a trawl. Conversely, the risk of entanglement could be quite small even if there are many marine mammals in an area if they have been foraging successfully and are inclined to avoid the disturbance of a trawl operation.

In any case, under the Status Quo and Preferred Alternatives, the “move-on” rule would be applied if any marine mammals are sighted from the vessel within 10 minutes before deploying trawl gear and appear to be at risk of interactions with the gear. If an area has a high density of marine mammals, they would likely be sighted during this 10 minute monitoring period prior to setting the gear and the station would be moved away or abandoned to avoid the marine mammals.

A special case of spatial/temporal restrictions would be for the NWFSC to avoid trawl survey work within federal and state MPAs (see Section 3.1.2). While the NWFSC has conducted survey work within some MPAs under the authority of special use permits, these permits primarily provide authority to scientifically sample fish in areas that are otherwise closed to fishing and do not concern the incidental take of marine mammals. The NWFSC will continue to apply for special use permits to sample in MPAs as necessary to meet the scientific needs of their surveys and, if the managing agencies of any MPAs prohibit such sampling, the NWFSC will avoid those areas. However, as described above, the same concerns about the effectiveness of spatial/temporal restrictions as a mitigation measure would apply to MPAs. They may or may not have high concentrations of marine mammals relative to the surrounding areas but, given the uncertainty about what factors contribute to high risk of entanglement in trawl gear and the imposition of the “move-on” rule, the potential for actually reducing incidental take by avoiding certain areas is not clear. Such avoidance also comes at the cost of not sampling in areas that are important to different fish species or that were established to promote recovery of depleted stocks. Scientific sampling is often the only reliable way to track the status of these stocks and the effectiveness of the MPA in fulfilling its established goals.

4.4.4.2 Longline Gear

The Marine Fish Research survey in the CCRA and the Marine Fish Research in the PSRA use, or propose to use, hook-and-line gear and would be subject to the following additional mitigation measures.

Monitoring Methods

The potential to use additional monitoring methods during hook-and-line surveys mostly involves the same considerations discussed with trawl surveys above. However, the potential to use dedicated PSOs is restricted primarily by vessel and crew size considerations. Longline surveys are conducted on smaller vessels than trawl surveys and the size of the crew is typically smaller. Under the Status Quo, at least one member of the crew is charged with watching for protected species before the gear is set. Dedicated PSOs would not be distracted by other vessel or research gear duties and would thus offer an advantage in monitoring for protected species. However, given the current size of vessels and crews used for these surveys, the inclusion of a crew member dedicated to only one task would compromise the ability of the remaining crew to conduct the survey safely.

Operational Procedures

This measure would require use of a decoy research vessel playing pre-recorded longline fishing sounds to distract marine mammals away from research longline sets. There have been no attempts to test the effectiveness of this method but it is likely that cetaceans would quickly learn to tell the difference between decoys and actual fishing operations (Gillman et al. 2006). Although the potential effectiveness is not clear, the additional cost of chartering another vessel to serve as a decoy would certainly compromise the research budget and restrict the amount of data that could be collected. In addition, a second vessel and broadcast fishing sounds would add to the amount of noise introduced to the marine

environment, potentially increasing the number of animals taken by disturbance (Level B takes) everywhere the survey was conducted.

Acoustic Deterrents

This measure would require the NWFSC to use deterrents such as acoustic pingers or recordings of predator (e.g., killer whales) vocalizations to deter interactions with longline gear. Although no marine mammals have been taken in longline gear during NWFSC fisheries research, takes of marine mammals on longline surveys in other regions involved animals hooked while depredating fish caught on the gear. Tests of the use of acoustic deterrents to mitigate depredation showed varying results. Signals emitted by pingers may decrease interactions of toothed whales with longlines by interrupting echolocation signals. Depredation by dolphins in the Mediterranean Sea appeared to decrease in response to some pingers, although distance from fishing vessels was not affected (Buscaino et al. 2011). Tests of similar devices in the tuna longline fishery off Hawaii indicate that the pingers probably reduced depredation rates (Nishida and McPherson 2011). Fixed frequency (10 kHz) acoustic pingers affixed to longlines in the South Pacific and Indian Oceans had a deterrent effect compared to random frequency (5-160 kHz) small pingers (Huang 2011). Adding pingers to the longline could also serve to attract animals rather than deter them (the “dinner bell” effect) (Jefferson and Curry 1996). As with trawl gear, attempts to scare animals off by playing killer whale recordings are likely to prove ineffective. In a draft review paper, Hamer et al. (2010) note that, although the use of predator playback has not been well studied, it may only work over short distances and individuals would likely habituate to the sounds. There is also the potential that introduction of these acoustic devices could deter or attract the target species, thereby compromising the continuation of the time-series data set.

Visual Deterrents

This measure would require the NWFSC to use visual deterrence techniques (e.g., lights, light sticks, reflective twine/rope, or marked lines) to make the longline gear more detectable thereby reducing the likelihood of hooking or entangling a marine mammal. This measure would theoretically reduce rates of interaction or entanglement for animals that have trouble detecting the fishing gear in order to avoid it (Gillman et al. 2006). Similarly, phosphorescent or luminescent material can be incorporated into fishing gear to emit light underwater at wavelengths that are visible to protected species. However, it is not clear that such measures to enhance the acoustic or visual appearance of trawl nets would have the same effect on all species. For some species that are attracted to the fish caught on the longline, efforts to increase the “visibility” of a longline set may increase the potential for interactions rather than decrease those risks. In addition, devices added to longline gear to increase their visibility may deter or attract the target species, potentially compromising the continuation of the time-series data set.

4.4.4.3 Conclusion

Under the Modified Research Alternative, the NWFSC would implement additional mitigation measures for protected species while conducting the same scope of research as described under the Preferred Alternative. Of the potential techniques and procedures considered under this alternative to improve monitoring of trawl gear, three techniques appear to offer some promise in helping to detect marine mammals in conjunction with the current visual monitoring protocol. These include the use of underwater video technology, passive acoustic monitoring, and unmanned aerial or underwater surveillance vehicles. However, all three techniques have substantial limitations in terms of conditions under which they may be useful (e.g. weather and sea state), the logistics of incorporating them into sampling procedures (e.g. timing of deployment, crew responsibilities, and data processing), and how they might be incorporated into actual marine mammal take-avoidance decisions like the “move-on” rule. These three techniques may warrant further examination to explore these limitations and to see how they may be applied under actual survey conditions if the technology advances and is improved. The other technological approaches

considered, infra-red imaging and use of night vision devices, have severe limitations to their usefulness in a real-world situation and therefore offer no advantages for actual mitigation.

The use of dedicated and trained personnel to monitor for protected species would occur under the Preferred Alternative once the crew and scientists of research surveys complete the new protected species training program. Currently, at least one member of the trawl survey crew or scientific party is dedicated to monitoring for protected species before research gear is deployed. Given the new protected species training program for all crew members under the Preferred Alternative, the use of dedicated PSOs for monitoring during trawl operations would offer limited advantage to what will occur under the Preferred Alternative.

Operational restrictions such as not allowing trawls to be set at night or in poor visibility conditions would certainly reduce the risk of taking marine mammals. However, part of their effectiveness may be due to reduced overall sampling effort rather than because marine mammals are more likely to be caught under those conditions. Such restrictions could have a serious impact on the ability of the NWFSC to collect certain kinds of research data and would have impacts to the cost and scope of research that could be conducted. The spatial/temporal restrictions that were considered to avoid high densities of marine mammals are similar in that they would reduce risk of take by reducing overall sampling effort but also strongly impact the ability of the NWFSC to pursue certain scientific goals.

The use of additional acoustic and visual deterrents may warrant further investigation if new devices enter the market and are demonstrated to be effective. However, the effectiveness of the devices considered in this alternative appears to be species specific; mitigation advantages for some species may lead to higher risk for other species. The effectiveness of these techniques may also decrease with time as animals habituate to various devices and techniques.

The analysis of additional measures considered to decrease the risk of marine mammal takes in hook-and-line gear is similar to trawl gear. Hook-and-line surveys are conducted on much smaller vessels with limited crew. Dedicated PSOs could offer an advantage for monitoring, but the lack of crew space is limiting; all crew members have multiple tasks that are necessary for safe navigation and to conduct the survey. Decoy vessels, acoustic deterrents, and visual deterrents are all unlikely to provide consistent mitigation value and may increase the risk for certain species. New variations on these techniques may be developed in the future that address some of these concerns. Thus far, there have been no takes of marine mammals by hook-and-line gear during NWFSC fisheries research.

In conclusion, some elements of the Modified Research Alternative (e.g., dedicated PSOs) could offer mitigation advantages compared to the Status Quo Alternative. The Modified Research Alternative does not, however, appear to offer a substantial reduction in the risk of adverse interactions with marine mammals compared to the Preferred Alternative other than through reducing overall fishing effort. The impacts of the Modified Research Alternative on marine mammals would therefore be similar to the impacts of the Preferred Alternative, which were considered minor adverse under the criteria described in Table 4.1-1. Some concepts and technologies considered in the Modified Research Alternative are promising and NMFS will evaluate the potential for implementation if they become more practicable.

4.4.5 Effects on Birds

The effects of the Modified Research Alternative on birds are very similar to those described for the Status Quo Alternative (Section 4.2.5) and essentially the same as the Preferred Alternative (Section 4.3.5). The exceptions involve two potential additional mitigation measures intended to reduce impacts on protected species.

The Modified Research Alternative includes potential spatial/temporal restrictions on where and when NWFSC fisheries research could occur. Such restrictions may reduce impacts on sea birds in certain areas such as marine protected areas if such closures were determined to be effective mitigation measures.

However, specific determinations about potential research restrictions have not been made and it is assumed that the overall research effort would be very similar under the Modified Research Alternative as it would be under the Status Quo Alternative. Overall effects on seabirds would therefore be similar even if research was conducted in somewhat different places and times. As an example, two seabirds, a Cassin's auklet and a tufted puffin, have been caught during NWFSC research within the Olympic Coast National Marine Sanctuary in the past (Section 4.2.5). Prohibiting NWFSC research within the Sanctuary may reduce the risk of birds in that area but the distribution of those two species, and all other seabirds, is not limited to the Sanctuary so the risk of capturing seabirds would just be displaced to other areas.

Another additional mitigation measure under the Modified Research Alternative would be for the NWFSC to deploy streamer lines on longline gear to reduce the risk of catching seabirds. Deploying streamer lines on each side of the baited longline to discourage seabirds from diving on baited hooks has proven effective in reducing seabird bycatch in some Pacific fisheries (Melvin et al. 2001). This measure would reduce the already-low risk to seabirds from NWFSC's longline surveys but given the lack of historical interactions of birds in this type of research gear, the practical effects on birds would likely be minimal. If seabird interactions with longline gear are documented in the future, the NWFSC will revisit whether use of streamer lines is warranted given the tradeoffs between the potential conservation benefit and changes to research protocols that might affect time-series data.

4.4.5.1 Conclusion

The overall effects of NWFSC research activities on birds under the Modified Research Alternative would likely be minor in magnitude, dispersed over a large geographic area, and temporary or short-term in duration, and would therefore be considered minor adverse according to the impact criteria in Table 4.1-1. This conclusion applies throughout the NWFSC research areas and for all gear types used in research.

4.4.6 Effects on Sea Turtles

The Modified Research Alternative would include the same scope of research activities as the Preferred Alternative but those activities would be conducted under different operating procedures and gears in order to mitigate, to the greatest possible extent, any potentially adverse impacts on protected species, including sea turtles. Most of these additional mitigation measures are being considered in this DPEA in order to address marine mammal protection issues under the MMPA (see Section 4.4.4) but many of them may have implications for avoiding potentially adverse interactions with sea turtles, including:

The use of dedicated protected species observers and additional equipment/technologies to improve monitoring.

- Operational restrictions on research activities in low visibility conditions.
- The use of acoustic and visual deterrents on selected gear types.
- Gear modifications, including turtle excluder devices on trawl nets.
- The incorporation of high-resolution, high-speed video cameras into trawl nets with open cod ends.
- Temporal or geographic restrictions to avoid known concentrations of marine mammals or federal and state MPAs.

The potential for these additional mitigation measures to reduce impacts on marine mammals and their practicability for implementation within NWFSC research protocols is addressed in Section 4.4.4. Many of the same logistical difficulties and concerns about impacts on the scientific mission of the surveys would be the same in regard to sea turtles as they would for marine mammals. However, the NWFSC has

no history of taking sea turtles in its research efforts so the likelihood of future takes is remote. Given the standard short tow/set times for NWFSC surveys, even if a turtle was captured in the future, it would likely be released in good condition. The potential impacts of NWFSC research on sea turtles are already minimal so the implementation of additional mitigation measures which may have adverse effects on the scientific mission of the surveys would not be warranted.

4.4.6.1 Conclusion

The overall effects of the Modified Research Alternative on ESA-listed sea turtles would likely be small in magnitude, dispersed over a large geographic area, and temporary or short-term in duration and would therefore be considered minor adverse on all species of sea turtles according to the criteria in Table 4.1-1.

4.4.7 Effects on Invertebrates

Under the Modified Research Alternative, the NWFSC would implement additional mitigation measures for protected species while conducting the same scope of research as described under the Preferred Alternative. Most of the additional mitigation measures would be unlikely to affect the amount of invertebrates caught for research purposes. The exceptions are the potential for spatial/temporal restrictions on NWFSC-affiliated research in areas considered important to protected species and the potential for incorporation of marine mammal or sea turtle excluder devices in research trawls.

Spatial/temporal restrictions could reduce research fishing and hence impacts on invertebrates in some locations. However, researchers may respond to spatial/temporal restrictions by redirecting research efforts to other locations if such movements are consistent with research goals and do not compromise time-series data sets. If so, overall research efforts could remain the same. The Modified Research Alternative does not specify particular spatial/temporal restrictions but it is assumed for the DPEA analysis that overall research effort and therefore impacts to invertebrates would be very similar under the Modified Research Alternative as they are for the Preferred Alternative, although they may occur in somewhat different locations and times.

The NWFSC has recently incorporated a marine mammal excluder device in the Nordic 264 surface trawl but not in other types of trawls. The incorporation of marine mammal or sea turtle excluder devices in other research trawls could affect the numbers, species, and size/age classes of invertebrates caught in the trawls, either as target species or as by-catch. It is not possible to estimate what the effects may be for any species of invertebrates if additional excluder devices or other gear modifications were mandated under the Modified Research Alternative.

It is assumed for this DPEA analysis that overall impacts to invertebrates under the Modified Research Alternative would be largely the same as those described under the Preferred Alternative. These effects would be low in magnitude, distributed over a wide geographic area, and temporary or short-term in duration and would therefore be considered minor adverse according to the criteria in Table 4.1-1. As was the case with the Status Quo and Preferred Alternatives, the Modified Research Alternative would also contribute to long-term beneficial effects on managed invertebrate species throughout the West Coast Region through the contribution of NWFSC-affiliated fisheries research to sustainable fisheries management.

4.4.8 Effects on the Social and Economic Environment

The effects of the Modified Research Alternative on the social and economic environment depend on the extent that additional mitigation measures would be implemented. Some of the mitigation measures require additional equipment than is currently used and the addition of trained protected species observers to the crew, which could increase spending on wages, rentals, and equipment. However, on surveys conducted on relatively small vessels with limited crew space, the inclusion of crew dedicated to

protected species monitoring would decrease the number of crew available to conduct research, thereby decreasing the amount of research that could be conducted in a given time period and potentially creating safety concerns. Other measures such as spatial/temporal restrictions could curtail research operations in areas important for stock assessment and fishery management purposes. Spatial/temporal restrictions may reduce some operational costs if surveys are reduced in scope, with a resulting loss of scientific information, but may also increase survey expenses if surveys need to be extended in time to compensate for restricted data collection opportunities.

The scientific value of data collected with changes in research protocols due to additional mitigation measures has not been evaluated because the number of unresolved variables would make any such analysis speculative. It is therefore uncertain if an altered NWFSC fisheries research program under the Modified Research Alternative would contribute a similar value to fisheries management as the Status Quo Alternative. However, it is probable that some of the additional mitigation measures included in the Modified Research Alternative, if implemented, would decrease the ability of the NWFSC to provide comparable levels or quality of scientific information to the fisheries management process. While these conditions may reduce the scientific value of NWFSC research relative to the Status Quo Alternative, the overall contribution of NWFSC research to the socioeconomic environment would likely be similar to those described for the Status Quo Alternative (Section 4.2.8).

The direct and indirect effects of the Modified Research Alternative on the social and economic environment would be certain to occur, minor to moderate in magnitude depending on the community, long-term, and would be felt throughout the West Coast region. According to the impact criteria established in Table 4.1-1, the direct and indirect effects of the Modified Research Alternative on the social and economic environment would be minor to moderate and beneficial.

4.5 DIRECT AND INDIRECT EFFECTS OF ALTERNATIVE 4 – NO RESEARCH ALTERNATIVE

This section presents an analysis of the potential direct and indirect effects of Alternative 4 – the No Research Alternative – on the physical, biological, and social environment. Under the No Research Alternative, NWFSC would no longer conduct or fund fieldwork for the fisheries and ecosystem research considered in the scope of this DPEA in marine waters of the Pacific. This moratorium on fieldwork would not extend to research that is not in scope of this DPEA, such as directed research on marine mammals and ESA-listed species covered under separate research permits and NEPA documents. NMFS would need to rely on other data sources, such as fishery-dependent data (i.e., harvest data), and state or privately supported data collection programs to fulfill its responsibility to manage, conserve, and protect living marine resources in the U.S.

The potential direct and indirect effects of implementing Alternative 4 were evaluated according to the criteria described in Table 4.1-1. A summary of the impact rating determinations for all topics evaluated under this Alternative are presented below in Table 4.5-1.

Table 4.5-1 Alternative 4 Summary of Effects

Resource	Physical Environment	Special Resource Areas	Fish	Marine Mammals	Birds	Sea Turtles	Invertebrates	Social and Economic
Section #	4.5.1	4.5.2	4.5.3	4.5.4	4.5.5	4.5.6	4.5.7	4.5.8
Effects Conclusion	Minor adverse	Minor adverse	Minor to Moderate adverse	Minor adverse	Minor adverse	Minor adverse	Minor to Moderate adverse	Moderate adverse

4.5.1 Effects on the Physical Environment

Under the No Research Alternative, the NWFSC would no longer conduct or fund fisheries and ecosystem research involving fieldwork in marine waters of the Pacific. This would eliminate the potential for direct adverse impacts to the physical environment from NWFSC-affiliated fisheries research, although such impacts may continue through research activities conducted and funded by other entities.

The research conducted by the NWFSC includes assessments of fisheries and marine habitat that are used to inform a wide range of plans, policies, and resource management decisions. Many of the plans, policies and decisions that are partially based upon NWFSC data are concerned with conservation of ecological properties of the environment and maintenance of the habitat that sustains living resources in the Pacific. FMPs developed for the region are partially based on scientific advice derived from NWFSC data. These FMPs strategically limit impacts to physical habitat such as disturbance of benthic habitat and removal of organisms that produce seafloor structure. Without a relatively continuous input of NWFSC data, especially time-series data extending over decades, management authorities would lose some of the information necessary to establish management measures in a meaningful fashion. It would also substantially reduce the capacity of NMFS to monitor and investigate changes to the physical environment and water quality due to coastal developments, marine industrial activities, and climate change among other factors.

The loss of information on physical resources under the No Research Alternative would affect a number of different federal and state resource management agencies to various degrees. The NWFSC research program is not the only source of information available to these resource managers but the No Research

Alternative could lead to changes in some management scenarios based on greater uncertainty. Given the potential for resource management agencies to compensate for this loss of information to some extent, and the preference to avoid rapid, major changes in management strategies, the potential magnitude of effects on the physical environment would likely vary from minor to moderate and be limited in geographic extent in the near future. Under the No Research Alternative, the overall impact of these indirect effects on physical resources would be considered adverse and minor according to the criteria in Table 4.1-1.

4.5.2 Effects on Special Resource Areas

The No Research Alternative would result in the elimination of the minor adverse direct impacts to special resource areas described in Section 4.2.2 for the Status Quo Alternative. However, the beneficial effects of NWFSC research on the conservation management of special resource areas would also be lost under the No Research Alternative.

The loss of scientific information from these areas would make it difficult for fisheries managers to assess the habitats, resources, and ecosystem functions that EFH Closed Areas, MPAs, and National Marine Sanctuaries are designed to protect through the implementation of sound science-based management practices. Furthermore, a loss of input from NWFSC research would handicap the maintenance and effective management of existing EFH Closed Areas, and would encumber the designation of additional special resource areas in the future. Implications from the loss of information about special resource areas under the No Research Alternative would vary for different federal and state resource management agencies. The NWFSC research program is not the only source of information available to these resource managers but eliminating this source of data could lead to changes in some management scenarios based on greater uncertainty (e.g., greater restrictions on commercial fisheries). If the NWFSC discontinued collecting information on special resource areas, especially from surveys with long time-series data, management authorities would lose important information needed to establish meaningful management measures and current conservation measures in place to protect ecological properties of the environment could become less effective. The indirect effects of these potential management implications would likely vary among the many special resource areas considered. Given the potential for resource management agencies to compensate for this loss of information to some extent and the tendency to avoid rapid, major changes in management strategies, the potential magnitude of effects on special resource areas would likely vary from minor to moderate and be limited to a few local areas in the near future. Under the No Research Alternative, the overall impact of these indirect effects on special resource areas would be considered minor adverse according to the impact criteria described in Table 4.1-1.

4.5.3 Effects on Fish

Under the No Research Alternative, there would be no direct effects of NWFSC-affiliated research on fish because the NWFSC would no longer conduct or fund fieldwork for fisheries and ecosystem research. The lack of at-sea research activities would eliminate the risk of mortality from fisheries research activities, disturbance and changes in behavior due to the presence of vessels and research gear, and potential contamination from vessel discharges. However, the loss of scientific information about fish populations and their habitats, especially commercially valuable species, would make it increasingly difficult for fisheries managers to effectively monitor stock status, set commercial harvest limits, or develop fishery regulations to recover depleted stocks or protect vulnerable stocks, especially as information used in stock assessments gets older and less reliable. For non-commercial species, the absence of new fieldwork conducted and funded by the NWFSC would interrupt time-series data sets important for tracking ecosystem-level changes due to fishing impacts, climate change, ocean acidification, and other factors. The loss of this information would increase uncertainty about future trends which may be important to natural resource managers, although the impact of this uncertainty on particular fish species is unknown.

The conservation and management of fishery resources is a core mission for NMFS and is listed among the ten National Standards set forth in the MSA. In carrying out Congress's mandate under the MSA, NMFS is responsible for ensuring that management decisions involving fishery resources are based on the highest quality, best available scientific information on the biological, social, and economic status of the fisheries. On the West Coast, this is achieved through the work of the NWFSC and Southwest Fisheries Science Center, which provide supporting scientific information that NMFS uses as the basis for their fisheries management actions. In addition to assessing the status of stocks and examining potential effects of commercial fishing activities, NMFS uses NWFSC research data in the development and implementation of FMPs. The ability to acquire scientific information is essential to the agency's responsibility to manage our nation's fishery resources.

Without NWFSC fisheries research, NMFS would need to rely on other data sources, such as fishery-dependent harvest data and state or privately supported fishery-independent data collection surveys or programs. It is unlikely that any of the state or other institutional research programs would be able to undergo the fundamental realignment of budgets and scientific programs necessary to maintain the level and continuity of information currently provided by the NWFSC.

Although other data sources are available to support resource management decisions, the No Research Alternative would be expected to result in increased uncertainty and changes in some management scenarios. If the NWFSC discontinued collecting information on fish stocks, management authorities would lose important information needed to establish sustainable harvest limits and other management measures in a meaningful fashion, and current conservation measures in place to rebuild overfished stocks and protect ecological properties of the environment would become less effective. The indirect effects of these potential management implications would likely vary among fisheries management areas and the different fish stocks assessed by the NWFSC. There are too many unknown variables to estimate what the indirect effects of this loss of information would mean to any particular fish stock. Given the potential for resource management agencies to compensate for this loss of scientific information to some extent and the tendency to avoid major changes in management strategies, the potential magnitude of effects on fish stocks would likely vary from minor to moderate but the effects could be regional in geographic scope and have long-term effects. Through these indirect effects on future management decisions, the overall impact on commercially important fish stocks would be considered moderate adverse for the areas surveyed by the NWFSC according to the criteria in Table 4.1-1. For other stocks that are not managed or do not have commercial or recreational fisheries, the indirect impacts would likely be minor.

4.5.4 Effects on Marine Mammals

Under the No Research Alternative, the NWFSC would no longer conduct or fund fieldwork for the fisheries and ecosystem research considered in the scope of this DPEA in marine waters of the U.S. West Coast, Puget Sound, and lower Columbia River. This would eliminate the potential for direct effects of NWFSC fisheries research on marine mammals through disturbance, injury and mortality in research gear, changes to prey fields, and contamination of the marine environment. This moratorium on fieldwork would not include research outside the scope of this DPEA, such as directed research on marine mammals and ESA-listed species covered under separate research permits and NEPA documents.

In addition to conducting fisheries research, NWFSC surveys are sometimes used as "ships of opportunity" for at-sea observational surveys of seabirds and marine mammals. Given the difficulty in getting long-term funding for dedicated surveys, these fairly consistent data collection opportunities on long-term NWFSC fisheries research cruises are valuable contributions to multidisciplinary ecosystem research efforts. Under the No Research Alternative, the use of NWFSC research cruises as ships of opportunity would be eliminated. While these opportunistic transects are not the primary source of information about the status of marine mammals, they do contribute to NMFS annual marine mammal stock assessments. Oceanographic and fisheries data collected by the NWFSC is also important for

monitoring the ecological status of the environment important to marine mammals. While there would be no direct effects on marine mammals due to adverse interactions with ships and scientific gear, the loss of observational and ecological information important to marine mammals could indirectly and adversely affect resource management decisions concerning the conservation of marine mammals, especially as time went on and uncertainty about the status of the marine environment increased. There are too many unknown variables to estimate the magnitude of effects this lack of information would mean to any particular stock of marine mammal but they would likely be minor in magnitude over the next five years. These indirect effects could have short-term to long-term effects on management of marine mammal species that interact with fisheries and have impacts over a large geographic area. Through these indirect effects on future management decisions, the overall impact on marine mammals would be adverse and minor according to the criteria in Table 4.1-1.

4.5.5 Effects on Birds

The No Research Alternative would result in the elimination of the minor adverse direct impacts to seabirds through disturbance, entanglement in gear, changes to prey fields, and contamination of the marine environment for all species of birds (Section 4.2.5). However, as discussed in the marine mammal section above, some of the NWFSC projects that would be eliminated under this alternative include seabird observations made from NWFSC research vessels which provide scientific data on the abundance and distribution of seabirds in the Pacific. This information contributes to ecosystem modeling and resource management issues important to seabirds. Oceanographic and fisheries data collected by the NWFSC is also important for monitoring the ecological status of the environment important to seabirds. While there would be no direct effects on seabirds, the loss of observational and ecological information important to seabirds could adversely affect resource management decisions concerning the conservation of seabirds. Although NMFS does not have regulatory jurisdiction over birds, the scientific contribution from the NWFSC observational research on seabirds is used, at least partially, to support fishery management decisions and USFWS conservation efforts. If the NWFSC discontinued collecting ecological and observational information on seabirds, long-term data sets contributing to the quality of information about seabird trends would be disrupted and adversely affect the ability of state and federal agencies to make informed decisions about seabirds and the marine environment, especially as time went on and uncertainty about the status of various populations of birds increased. Given the fact that the seabird-related data from NWFSC fisheries research cruises is not the only source of information available to federal and state resource managers, and the potential for resource managers to compensate for this loss of information to some extent on other vessels of opportunity, the No Research Alternative is expected to have an adverse and minor indirect effect on seabirds in the NWFSC research area.

4.5.6 Effects on Sea Turtles

Under the No Research Alternative, the NWFSC would no longer conduct or fund fisheries research involving fieldwork in marine waters, which would eliminate the potential for minor adverse impacts to sea turtles through disturbance, entanglement in gear, changes to prey fields, or contamination associated with NWFSC research activities.

As discussed in the marine mammal and bird sections above, some of the NWFSC projects that would be eliminated under this alternative include sea turtle observations made from NWFSC research vessels which provide scientific data on the abundance and distribution of sea turtles in the Pacific, including critical habitat for leatherback turtles. This information contributes to ecosystem modeling and resource management issues important to sea turtles. The elimination of NWFSC research activities would also substantially reduce the collection of oceanographic and fisheries data important for monitoring the ecological status of the environment important to sea turtles. These data are used, at least partially, to manage and conserve sea turtle populations and the habitats and ecosystems that sustain them. However,

collection of data on sea turtles is not the primary focus of NWFSC fisheries research and there are other sources of scientific data used by sea turtle biologists to monitor the status of different species.

There are too many unknown variables to estimate what the indirect effects of this loss of information and associated management implications would mean to any particular sea turtle species but all of them are considered important resources because of ESA-listing. Under the No Research Alternative, the loss of information currently provided by NWFSC research activities is expected to have adverse and minor indirect effects on ESA-listed sea turtles in the Pacific.

4.5.7 Effects on Invertebrates

Under the No Research Alternative, there would be no direct effects of NWFSC research on invertebrates through mortality, benthic habitat disturbance, or potential contamination from vessel discharges. However, the loss of scientific information about invertebrates, particularly commercially valuable species, would impede the ability of fisheries managers to effectively assess and monitor stocks, set harvest limits, or develop necessary regulations to protect vulnerable stocks. For non-commercial species, the absence of new fieldwork conducted and funded by the NWFSC would interrupt time-series data sets important for tracking ecosystem-level changes due to fishing impacts, climate change, ocean acidification, and other factors. The loss of this information would increase uncertainty about future trends which may be important to natural resource managers, although the impact of this uncertainty on particular invertebrate species is unknown.

As described in Section 4.5.3 for fish, the conservation and management of marine invertebrate resources is a core mission for NMFS under the MSA and needs to be based on the best available scientific information. In addition to assessing the status of invertebrate stocks and examining potential effects of commercial fishing activities, NMFS uses NWFSC research data to develop and implement FMPs. The ability to acquire scientific information is essential to the agency's responsibility to manage our nation's fishery resources.

Without NWFSC-affiliated fisheries research, NMFS would need to rely on other data sources such as fishery-dependent harvest data and state or privately supported fishery-independent data collection surveys or programs. It is unlikely that any of the state or other institutional research programs would be able to undergo the fundamental realignment of budgets and scientific programs necessary to maintain the level and continuity of information currently provided by the NWFSC.

Although other data are available to support resource management decisions, the interruption or cessation of long-term data series on commercially valuable invertebrate stocks as well as other important marine ecosystem components could lead to increased uncertainty and changes in some management scenarios. Management authorities would lose important information needed to establish sustainable harvest limits and help conserve and restore benthic habitats. Given the potential for resource management agencies to compensate for this loss of scientific information to some extent and the tendency to avoid major changes in management strategies, the potential magnitude of indirect effects on invertebrate stocks would likely vary from minor to moderate, but the effects could be regional in geographic scope and have long-term effects. Through these indirect effects on future management decisions, the overall impact on commercially important invertebrate stocks would be considered minor to moderate in magnitude, distributed over a wide geographic area, and long-term in duration and would therefore be considered minor to moderate adverse according to the criteria in Table 4.1-1.

4.5.8 Effects on the Social and Economic Environment

Section 3.3 describes the interaction of the NWFSC with the social and economic environment of the U.S. West Coast. This section describes the effects of the No Research Alternative on socioeconomic resources

of the West Coast region. Major factors that would be affected by the cessation of fieldwork associated with the NWFSC fisheries research program include:

- Collection of scientific data used in sustainable fisheries management
- Economic support for fishing communities
- Tribal Co-management of Fisheries and Marine Resources
- Fulfillment of legal obligations specified by laws and treaties

4.5.8.1 Collection of Scientific Data used in Sustainable Fisheries Management

Under the No Action Alternative, the NWFSC would not conduct or fund fisheries research involving the deployment of vessels or fishing gear in marine waters of the U.S. West Coast. Without the scientific data for updated stock and habitat assessments provided by NWFSC research, scientists and fisheries managers would have to rely on other data sources, such as commercial and recreational fisheries harvest data and fisheries-independent research conducted and funded by state agencies, academic institutions, or other independent research organizations. This would have a direct adverse effect on the statistical confidence of stock assessments and other scientific information important to fisheries management. Without federal fisheries-independent research, areas closed to fishing for various conservation reasons, such as stock or habitat recovery, would be without the primary scientific data used to monitor the effectiveness of those conservation measures and the recovery of depleted species.

The use of fishery-dependent data alone may severely limit the ability of managers to evaluate and make predictions about the status of some stocks because harvest data do not sample early age classes and therefore provide little data on potential recruitment to harvestable stocks. Uncertainty about stock assessments would increase over time as knowledge of population structures diminish. This, in turn, could require use of ever more precautionary approaches, which could reduce commercial, recreational, and tribal fishing opportunities, and therefore associated income, through such means as reduced fishing quotas or target catch levels and/or extended closures of fishing areas. The redistribution of research effort to non-NMFS entities would also require reliance on communication with the Fishery Management Councils, new data review processes, and new procedures for integrating separate research results into the regional perspective. Cessation of fisheries research conducted and funded by the NWFSC would gradually undermine the statistical basis for use of more sophisticated management models, leading to reliance on less sophisticated and more conservative fishery management.

Another potential result of greater uncertainty in the scientific basis for fisheries management is that fisheries managers may overestimate overfishing levels and set harvest limits too high for some species, resulting in overfishing and depletion of fish stocks. The initial effect of this would be to increase the revenues from commercial fishing and its related industries. However, over time, the depletion of fish stocks would result in lower catches and therefore reduced incomes. Further, quotas that are lower than objectively necessary mean not only losses to the fishing industry, fisheries dependent shore side industries and fishing families and communities, but also losses to the Nation through foregone revenue from missed harvesting opportunities. And even with a precautionary approach, in the absence of objective data, quotas may still be set too high; meaning the long-term yield from the fishery will be driven down due to unsustainable harvest levels. This would result in both a conservation loss and a long-term economic loss to the West Coast region and the Nation.

The absence of federal fishery-independent research surveys and the long-term data sets they provide would eliminate the primary set of trend information used to monitor broad changes in the marine ecosystem. Climate change and ocean acidification have the potential to impact the population and distribution of many marine species. Long-term, scientifically robust research that provides information on changes to and trends in the marine ecosystem, and on human impacts from and adaptations to those

changes and trends, would be greatly diminished if the NWFSC ceased conducting and funding fisheries and ecosystem fieldwork.

The end result could be an undermining of confidence in the fisheries management program. This could lead to less cooperation and exchange of important information and data. Without this cooperation the interstate commissions and Fishery Management Councils would find it more difficult to sustain the support of the individual states, potentially undermining the fisheries management process. The No Research Alternative clearly does not enable collection and development of adequate, timely, high quality scientific information comparable to that provided by the NWFSC under any of the three research alternatives. In NMFS view, the inability to acquire scientific information essential to developing fisheries management actions that must prevent overfishing and rebuild overfished stocks would ultimately imperil the agency's ability to meet its mandate to promote healthy fish stocks and fully restore the nation's fishery resources.

4.5.8.2 Economic Support of Fishing Communities

The NWFSC currently spends approximately \$7.5 million annually in support of fisheries research that support local economies in the form of employment, services, chartered vessels, fees, taxes, equipment, and fuel. Under the No Research Alternative, this financial contribution to local economies and the resulting support of the social environment would cease. A number of people currently employed to conduct fisheries research either as federal employees or contractors would likely lose their jobs and the number of support services required for the NWFSC would decrease substantially. It is unlikely that tribal, state agencies or other funding sources would be able to completely compensate for this loss of federal funding to support fisheries research by tribal governments, state agencies, academic institutions, and industry groups.

While the loss of research-related employment and purchased services would be important and adverse for many individuals and families, the total sums spent for research are very small compared to the value of commercial, recreational, and tribal fisheries in the area as well as the overall economy of those communities. The lost economic contribution of NWFSC research would be relatively larger for some communities where the research is centered and may be considerate moderate in magnitude for those communities but the overall direct impact of that loss would be minor in magnitude for most communities. These direct adverse economic impacts would be certain to occur under the No Research Alternative, would affect numerous communities throughout the region, and could be felt for several years. Overall, the direct economic impacts of the No Research Alternative would be considered minor to moderate and adverse according to the impact criteria in Table 4.1-1.

4.5.8.3 Tribal Co-management of Fisheries and Marine Resources

Under the No Research Alternative, the cessation of NWFSC research activities would eliminate any direct impacts on tribal marine resources and usual and accustomed resource areas but it would have adverse impacts on the existing co-management of fisheries resources and could have adverse indirect impacts on marine resources important to the tribes. As outlined in Section 4.2.8, the survey data from NWFSC research currently provides the basis for federal fisheries management in the region and contributes to co-management of tribal fisheries. Without NWFSC data for updated stock and habitat assessments, tribes and fisheries managers would have to rely solely on data sources from tribal researchers, state agencies, academic institutions, or other independent research organizations. This reliance on non-NWFSC data would impair the ability of the Fishery Management Councils and NMFS to set optimum yield fishery harvest levels for commercial fisheries and to contribute to the sustainable management of tribal marine resources. As a result, under the No Research Alternative, the government's ability to fulfill trust responsibilities with the tribes would be impaired.

4.5.8.4 Fulfillment of Legal Obligations Specified by Laws and Treaties

The cessation of field work associated with the NWFSC research programs considered in this DPEA would compromise the ability of NMFS to fulfill its obligations under various U.S. laws and treaties (Chapter 6). NMFS manages finfish and shellfish harvest under the provisions of several major statutes, including the MSA, MMPA, and the ESA. Fulfilling the obligations of these statutes requires NMFS to provide specific research data and scientific expertise to support legal reviews and management decision-making processes. The cessation of field research would substantially erode the value of scientific advice provided to these various processes and increase uncertainty about the effects of conservation and management measures on fishing communities as well as NMFS ability to provide socioeconomic analyses required for fisheries regulatory actions. It would also compromise the U.S. partnership and collaboration with other agencies, entities, and countries that collect, analyze, and share complementary data for management of cross-boundary species and other international resources.

4.5.8.5 Conclusion

The direct and indirect effects of The No Research Alternative on the social and economic environment would be subject to a great deal of uncertainty depending on the response of many entities to the cessation of NWFSC fisheries research and the ensuing uncertainty in the fisheries management process. The impacts on the economies of local communities would be adverse, minor to moderate in magnitude depending on the community, long-term in duration, and would be felt throughout the West Coast region. The loss of research related to cross-boundary species would compromise the ability of the U.S. to comply with its international obligations. The loss of cooperative research programs between state and tribal organizations would also cause deterioration in the relationships between NMFS scientists and fisheries managers with the fishing industry, tribes, and the public, with decreasing public trust in fisheries management regulations. The overall direct and indirect effects of the No Research Alternative on the social and economic environment would be minor to moderate in magnitude, felt across a broad geographic area, and long-term and would therefore be considered moderate adverse according to the impact criteria established in Table 4.1-1.

4.6 COMPARISON OF THE ALTERNATIVES

The following discussion compares and contrasts the direct and indirect impacts of the four alternatives on each resource area. The first three alternatives are much more similar to each other than to Alternative 4 because they all involve robust and extensive fisheries research programs affiliated with the NWFSC, either through active participation in the conduct of the research, or by funding cooperative research partners. Alternative 4 is quite different from the other alternatives in that it does not include additional fieldwork conducted or funded by the NWFSC.

Alternative 1, the No Action/Status Quo Alternative, includes the research program as it existed in the previous five years, although some of the surveys/projects conducted in that period have not been conducted recently or were short-term projects that were not intended to be continued in the future. The mitigation measures for protected species under Alternative 1 are those that were in place at the end of 2013.

Alternative 2, the Preferred Alternative, includes the suite of research surveys/projects that are currently being conducted and anticipated to be conducted in the foreseeable future. It also includes the current suite of mitigation measures for protected species and several proposed improvements to protected species mitigation training and reporting procedures. These new efforts are intended to improve the consistency and effectiveness of how the NWFSC and its research partners implement mitigation measures to reduce adverse interactions on protected species.

Alternative 3, the Modified Research Alternative, is the same set of research activities as Alternative 2 but it includes a range of additional mitigation measures for protected species that are not included in Alternative 2. These additional mitigation measures include operational restrictions as well as the potential incorporation of gear modifications into research protocols. Many of these additional mitigation measures would impact the collection of fisheries and ecosystem research data or require expensive and extensive testing before they could be implemented, and are therefore not part of the Preferred Alternative.

Under Alternative 4, the No Research Alternative, the NWFSC would no longer conduct or fund fieldwork for the fisheries and ecosystem research considered in the scope of this DPEA. Under the No Research Alternative, it is unlikely that any of the state or other institutional research programs would be able to undergo the fundamental realignment of budgets and scientific programs necessary to maintain the level and continuity of information currently provided by the NWFSC. NMFS would need to rely on other data sources, such as fishery-dependent data (e.g., harvest data) and state, tribal, or privately supported fishery-independent data collection surveys or programs to fulfill its responsibility to manage, conserve and protect living marine resources in the U.S.

The effects of the alternatives on each resource category were assessed using an impact assessment criteria table to distinguish between major, moderate, and minor effects. The analysis shows that all three of the research alternatives could directly and indirectly impact the physical and biological environments in similar ways, and that the effects would be minor and adverse. In addition, the three research alternatives would have indirect beneficial effects on many biological resources and special resource areas through their contribution of scientific information to various resource management and conservation processes. The three research alternatives would also have minor to moderate beneficial effects on the social and economic environment of fishing communities by providing the scientific information needed for sustainable fisheries management and by providing funding, employment, and services. The No Research Alternative, in contrast, would eliminate the direct adverse effects of the research alternatives on the marine environment, but would have minor to moderate indirect adverse effects on the social and economic environment through long-term and widespread adverse impacts on sustainable fisheries management. Table 4.6-1 provides a summary of impact determinations for each resource by alternative.

Table 4.6-1 Summary of Environmental Effect Conclusions for Each Alternative

Topic	Alternative 1 (Status Quo)	Alternative 2 (Preferred)	Alternative 3 (Modified Research)	Alternative 4 (No Research)
Physical Environment	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor <i>adverse</i>
Special Resource Areas	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor <i>adverse</i>
Fish	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor to Moderate <i>adverse</i>
Marine Mammals	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor <i>adverse</i>
Birds	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor <i>adverse</i>
Sea Turtles	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor <i>adverse</i>
Invertebrates	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor <i>adverse</i>	Minor to Moderate <i>adverse</i>
Social and Economic Environment	Minor to Moderate <i>beneficial</i>	Minor to Moderate <i>beneficial</i>	Minor to Moderate <i>beneficial</i>	Minor to Moderate <i>adverse</i>

4.6.1 Summary of Effects on the Physical Environment

Under the three research alternatives, direct impacts to benthic habitats would primarily occur through the use of bottom-contact trawl equipment from groundfish surveys, hake acoustic surveys, and bycatch reduction surveys.. This DPEA includes an analysis of the total footprint of NWFSC-affiliated research on benthic habitat. Under Alternative 1, NWFSC-affiliated research directly impacts a small percentage of the sea floor each year with bottom trawl gear; about 0.009 percent of the total CCRA survey area is affected in an average year. Most of the bottom trawl surveys occur in mud/silt or sand/gravel benthic habitats, and any disturbances to such substrates would be expected to recover with 18 months due to the action of ocean currents and natural depositions. Water quality could be affected through disturbance of bottom sediments, causing temporary and localized increases in turbidity. Resuspension of fine sediments and turnover of sediment could also result in localized increases in the concentrations of dissolved organic material, nutrients, and trace metals in seawater near the seafloor. Although unlikely, water quality may also be affected by discharge of contaminants from vessels during research surveys. However, strict adherence to MARPOL and other pollution prevention regulations minimizes or negates the likelihood of discharges of potentially harmful substances into the water. The overall effects on benthic habitat and water quality are considered small in magnitude, short-term in duration, and localized in geographic scope and are therefore considered minor adverse under all three of the research alternatives, as they would all have similar impacts on the physical environment.

Under the No Research Alternative, there would be no direct impacts on the physical environment from NWFSC fisheries and ecological research. However, the loss of scientific information generated by NWFSC research would contribute to greater uncertainty about the effects of climate change, ocean acidification, commercial fisheries impacts, and other external factors on benthic ecosystems. Indirect effects could occur through less scientifically informed decisions by resource management agencies. The loss of information from the NWFSC would likely affect a large geographic area but would be minor in

magnitude given other potential sources of scientific research data. Impacts to the physical environment would therefore be considered minor adverse under the No Research Alternative.

4.6.2 Summary of Effects on Special Resource Areas

Under the three research alternatives, direct impacts to EFH, EFHCA, MPAs, and NMS would occur through the use of bottom trawl equipment and mortality of fish and invertebrates in other gears. As described for the physical environment, the effects of NWFSC-affiliated research on benthic habitat are considered small in magnitude, short-term in duration, and localized in geographic scope. Under Alternative 1, NWFSC bottom trawls directly impacts a small percentage of special resource areas; about 0.007 percent of the total EFHCA area, and 0.006 percent to 0.009 percent of National Marine Sanctuaries. The annual number of research trawls conducted within special resource areas in the NWFSC research areas and the removals of fish and invertebrates for scientific purposes are relatively small, therefore any adverse effects on special resource areas would be temporary and minor. Impacts to special resource areas under Alternative 2 would be very similar to the impacts under Alternative 1. Alternative 3 includes the potential for spatial/temporal restrictions on NWFSC fisheries research as a means to reduce impacts on protected species. This provision may reduce impacts on certain areas if such closures were determined to be effective mitigation measures. However, specific determinations about potential research restrictions have not been made and it is assumed that impacts to special resource areas under Alternative 3 would be very similar to those under Alternatives 1 and 2.

Under the No Research Alternative, there would be no direct impacts on special resource areas from NWFSC-affiliated fisheries and ecological research. However, the indirect effects on resource management agencies and conservation plans for protected areas due to the loss of scientific information would be similar to that described for the physical environment and would be considered minor adverse.

4.6.3 Summary of Effects on Fish

The NWFSC conducts and funds stock assessment and habitat research for many commercially valuable and recreationally important fish species, providing the scientific basis for sustainable fisheries management. NWFSC research also provides critical information on oceanographic conditions and the status of other fish species that are not harvested but which play key roles in the marine food web, providing the scientific basis for NMFS goal of ecosystem-based management, as outlined in NOAA Fisheries Strategic Plan (NOAA 1997). Under the three research alternatives, relatively small adverse impacts to fish populations are expected as a result of on-going research activities.

ESA-listed fish species have been caught by NWFSC research surveys using bottom trawls, mid-water trawls, surface trawls, and purse seines in the CCRA; hook-and-line, surface trawls, and beach seines in the PSRA; and beach seines, trap nets, and tangle nets in the LCRRA. Some ESA-listed non-salmonid species have been caught during NWFSC research surveys in the CCRA and PSRA (Puget Sound/Georgia Baisn DPS canary rockfish, and Pacific eulachon). No ESA-listed non-salmonid species have been caught during NWFSC research in the LCRRA. ESA-listed salmonid species caught during NWFSC research surveys include Puget Sound/Coastal DPS bull trout, numerous ESUs of Chinook salmon, Columbia River and Hood Canal Summer-run chum salmon, several ESUs of coho salmon, Snake River sockeye salmon, and numerous DPSs of steelhead. However, almost all of the ESA-listed salmonids caught are juveniles and most of these fish are returned to the water after careful processing. The overall adverse effects to ESA-listed species are therefore minor.

While mortality to target and other fish species is a direct effect of the NWFSC surveys and research projects, there are likely no measurable population changes occurring as a result of these research activities because they represent such a small percentage of fish taken in commercial fisheries, which are just fractions of the total populations for these species (Table 4.2-13). For a few species which do not have a large commercial market due to various market conditions or past overfishing, the research catch

exceeds one percent of commercial catch but is still very small relative to the population of each species. The DPEA uses an average level of catch and bycatch over the status quo period to determine the impacts of research on fish species based on their current or recent stock status and conservation concerns. However, the status of fish stocks varies over time and by fishery management region. If a future project proposes to conduct research on a fish stock that is overfished or depleted at the time, or if it would occur in areas and with gear that would likely result in substantial bycatch of overfished stocks, the potential effects of the proposed research project could be much greater than estimated in this DPEA and could conflict with rebuilding plans or present other conservation concerns. These future research projects may require additional NEPA analyses before they are issued research permits.

In contrast to the adverse effects of research on fish, NWFSC research also provides long-term beneficial effects on target species populations through its contribution to sustainable fisheries management.

The suite of research programs conducted under Alternatives 2 and 3 are similar but not the same as Alternative 1; several past surveys/projects have been discontinued or modified and several new research programs are anticipated to begin in the near future. Under Alternative 2, several new or modified projects would affect ESA-listed fish species: the Eulachon Arrival Timing project, ESA-listed Rockfish Genetics, Skagit Bay Juvenile Salmon Survey, and Puget Sound Marine Pelagic Food Web project. The Eulachon Arrival Timing project would capture Pacific eulachon with mid-water trawls and release most fish alive. The ESA-listed Rockfish Genetics project would target ESA-listed rockfish in Puget Sound and take non-lethal tissue samples from fins and release most fish alive. The increased effort to collect broodstock in all three NWFSC research areas have the potential to increase the number of interactions with ESA-listed rockfish or other species. Surface trawl effort in the Skagit Bay Juvenile Salmon Survey would be reduced by about a third (from 250 trawls to 180 trawls). The substantial reduction in fishing effort for this project should result in reduced risk of catching bull trout in the PSRA. Sampling effort with surface trawls would be reduced by 50 percent relative to the Status Quo Alternative (from 500 trawls to 250 trawls) in the Puget Sound Marine Pelagic Food Web project.

The NWFSC considers the potential for adverse impacts of its various research activities under Alternative 2 on ESA-listed salmonids to be very small in magnitude, dispersed in time and geographic area, and likely to have minimal impact on all ESUs in all three research areas. In contrast to these minor adverse effects, NWFSC research on Pacific salmon has beneficial impacts on both ESA-listed and non-listed ESUs through its contribution to sustainable fisheries management, reducing bycatch of vulnerable ESUs, helping to monitor the recovery of ESA-listed species, and monitoring changes in the marine environment important to the recovery of these species.

Another potential difference with regard to research catch of fish is the potential for spatial/temporal restrictions on NWFSC-affiliated research under Alternative 3. If particular areas and times were determined to be important to avoid as a means to reduce impacts on protected species, research fishing and hence impacts on fish could be reduced in some locations. However, researchers may respond to spatial/temporal restrictions by redirecting research efforts to other locations such that overall research effort remains the same. Alternative 3 does not specify particular spatial/temporal restrictions but it is assumed for the DPEA analysis that overall research effort and therefore impacts to fish under Alternative 3 would be very similar to those under Alternative 2, although they may occur in somewhat different locations.

Under the No Research Alternative, there would be no direct adverse impacts on fish from NWFSC-affiliated fisheries research. However, the loss of scientific information for fisheries management could impact fish stocks through increasing uncertainty in fisheries management decisions, which could lead to potential overfishing on some stocks, uncertainty about the recovery of overfished stocks, and increasing uncertainty about the efficacy of fishing regulations designed to protect fish stocks and habitat from overfishing. Inappropriate management decisions could have minor to moderate magnitudes of effects on given stocks, depending on how fisheries managers responded to the loss of scientific information from

the NWFSC. These indirect effects would likely be long-term and occur over a large geographic area. The overall impacts to fish stocks under Alternative 4 are therefore considered minor to moderate adverse.

4.6.4 Summary of Effects to Marine Mammals

The DPEA analyzes several types of potential effects of NWFSC fisheries research on marine mammals, including ship strikes, contamination of the marine environment, removal of marine mammal prey, and incidental take through use of active acoustic instruments, the physical presence of researchers, intentional hazing of nuisance animals (LCRRA only), and interactions with research gear. Given the same basic scope of research effort in all three research alternatives (although some details would be different), and the use of the same vessels and research gear, the potential effects from all of these factors except incidental take by entanglement or capture in research gear are considered the same for the three research alternatives. The differences regarding incidental take by entanglement or capture in research gear are further described below.

All research vessels comply with existing laws to reduce the risk of ship strikes (i.e., vessel speed restrictions in certain places and times to minimize the risk of collisions with large whales). No collisions with large whales have been reported from any fisheries research activities conducted or funded by the NWFSC. Given the relatively slow speeds of research vessels, the presence of bridge crew watching for marine mammals during many survey activities, and the small number of research cruises, ship strikes with marine mammals during the research activities described in this DPEA would be unlikely to occur in the near future.

NWFSC-affiliated fisheries research removes very small amounts of fish, invertebrates, and plankton relative to the amount estimated to be consumed by marine mammals every year. These research removals are distributed broadly throughout the research area in numerous brief, small sampling efforts. These small removals are unlikely to affect the prey availability or foraging success of any marine mammals.

All NOAA vessels and NWFSC chartered vessels are subject to the regulations of MARPOL 73/78, the International Convention for the Prevention of Pollution from Ships, which prohibits discharges of potentially harmful substances into the marine environment. In addition, all NOAA vessels are fully equipped to respond to emergencies, including fuel spills, and crew receive extensive safety and emergency response training. These precautionary measures help reduce the likelihood of fuel spills occurring and increase the chance that they would be responded to and contained quickly. Accidental spills of noxious compounds from research vessels could occur but would likely be rare, temporary, and localized and would be unlikely to have any adverse effects on marine mammals.

All three research alternatives would use the same type of acoustic instruments for reconnaissance and scientific mapping/survey purposes. These devices produce sounds that may be detected by marine mammals and cause changes in their behavior which would constitute Level B harassment under the MMPA. None of the NWFSC acoustic equipment is likely to present risks of hearing loss or injury to any marine mammal. The NWFSC LOA application (attached to this DPEA as Appendix C) includes estimates of Level B harassment takes through the use of acoustic instruments in the NWFSC research area using the scope of research and mitigation measures described in Alternative 2, which is assumed to be the same amount of Level B harassment that would take place under Alternatives 1 and 3 (see Table 4.2-15). The analysis is based on sound characteristics of the instruments, the distance research vessels travel with these instruments engaged, calculations of volumes of water insonified to 160 decibels (root mean square) or more (NMFS current recommended threshold for Level B harassment from the active acoustic equipment considered in this DPEA), and density estimates for each marine mammal species in the research area. The numbers of Level B takes for each species are small and the potential effects are likely to be temporary. The overall impact of acoustic disturbance to marine mammals under any of the three research alternatives is therefore considered to be minor adverse. As described earlier, Alternative 3

includes potential spatial/temporal restrictions that may lead to differences in where and when effects on marine mammals occur relative to Alternatives 1 and 2.

The primary difference between the alternatives regarding marine mammals involves incidental take through entanglement or capture in fisheries research gear, and the mitigation measures used to reduce the risk of those interactions. Incidental take of marine mammals in research gear includes animals captured, hooked, or entangled in fishing gear but released without serious injury (Level A harassment under the MMPA), and incidental capture or entanglement resulting in serious injury or mortality. The MMPA requires applicants for regulations and subsequent LOAs to estimate the number of each species of marine mammal that may be incidentally taken by harassment or serious injury and mortality during the proposed action. Because it is impossible to predict whether a future interaction will lead to serious injury or mortality or whether the animal may be released with only non-serious injury, the NWFSC has combined its estimates for Level A harassment and serious injury and mortality in its LOA application.

The estimated take numbers are based on the historical capture of 26 non-ESA-listed cetaceans (24 Pacific white-sided dolphins and two undetermined delphinid species) and 15 pinnipeds (four California sea lions, eight eastern DPS Steller sea lions (which were ESA-listed as threatened at the time of capture but have recently been de-listed), one northern fur seal, and two harbor seals) in the CCRA, and one harbor seal in the PSRA during NWFSC research surveys from 1999 through 2014 (Table 4.2-14). Past marine mammal captures during NWFSC surveys have all occurred using surface trawls. Of the 40 animals captured, only one California sea lion and one harbor seal was released alive. Take estimates for species that have not been caught in NWFSC research gear in the past are based on their similarity to species that have been taken historically by the NWFSC and by incidental take in analogous commercial fisheries. The NWFSC considers the estimation method used in the LOA application to be conservative in that it will likely overestimate the number of animals and species that would be caught in the future in order to ensure accounting for a precautionary amount of potential take. The DPEA uses the estimated takes in the LOA application to assess the impacts on marine mammals for all three research alternatives in the CCRA, PSRA, and LCRRA (Table 4.2-16). Given the likelihood that these are overestimates, the actual effects from injury, serious injury or mortality could be substantially less than described. For almost all stocks for which take is requested, except for two stocks of bottlenose dolphin, the average annual take in all gear types and all research areas combined is well below 10 percent of PBR for all species, even if all annual takes were from a single stock for species with multiple stocks. This level of mortality, were it to occur, would be considered minor in magnitude for all stocks. However, the NWFSC take request also includes “undetermined dolphin or porpoise” takes to account for similar-looking animals that may escape from the net or hook-and-line gear before being brought on board or identified. If, for impact analysis purposes, these undetermined takes are assigned to each stock in addition to those takes requested for the particular stock, the combined take request would still be well below 10 percent of PBR for most stocks and would be considered minor in magnitude. The potential exceptions are for stocks with very small PBR values, i.e. one coastal and one offshore stock of bottlenose dolphin where these added takes could represent between 10 percent and 50 percent of PBR and be considered moderate in magnitude relative to PBR. However, the assumptions of this worst case scenario are highly unlikely to occur given the lack of historical takes for this species, let alone these particular stocks. The chances of all future “undetermined” delphinids actually coming from any one stock are so remote as to be discountable. In addition, the small population sizes of these stocks, the limited scope of NWFSC research efforts within their ranges, and the mitigation measures in place to avoid marine mammal interactions (see Section 2.2.2) further reduce the risk of gear interactions with these stocks. The NWFSC therefore considers the potential effects of NWFSC research on these stocks to be minor.

The main difference between the alternatives in regard to marine mammals is the mitigation measures that would be implemented to reduce the risk of marine mammal interactions with research gear. The DPEA does not attempt to quantify the effectiveness of the different mitigation measures considered in the different alternatives; the analysis provides a qualitative description of how such measures could reduce

the risk of interactions with marine mammals and how their incorporation into scientific protocols may impact the fisheries research programs.

Alternative 1 represents the Status Quo conditions as they existed up through 2013, although the implementation of mitigation measures has not been static over the past ten years. Alternative 1 mitigation measures for marine mammals include at least one member of the ships' crew or scientific party designated to monitor for marine mammals before any research fishing gear (trawls, gillnets, longlines, etc.) are deployed. Except for a few research projects conducted from small boats with limited crew, these designated monitors are dedicated to this task and are not responsible for other tasks while looking for marine mammals (or other protected species). If any marine mammals are sighted around the vessel before setting the gear, the vessel may be moved away from the animals to a different section of the sampling area if the animals appear to be at risk of interaction with the gear; this protocol is called the move-on rule. The crew standing watch continue to monitor the waters around the vessel while the gear is in the water and, if any marine mammals are sighted that appear to be in danger of interacting with the gear, the gear may be removed from the water immediately or other appropriate actions taken to reduce the risk. Standard tow and set durations have also been reduced to minimize the risk of serious injuries and drowning.

Alternative 2 includes these same mitigation measures plus some additional measures and gear modifications. The Juvenile Salmon PNW Coastal Survey will include a marine mammal excluder device on the Nordic 264 surface trawl. The NWFSC is experimenting with different configurations of the excluder device to reduce unwanted impacts on research results (fishing selectivity) while maintaining the potential effectiveness of the device for marine mammal exclusion. For the Pair Trawl Columbia River Juvenile Salmon Survey, experimental development of large flexible antenna housings for PIT-tag detection was begun in 2013. The NWFSC is testing the potential to replace the pair trawl net with a matrix of such large coiled antennas towed at high speed, which would eliminate the risk of marine mammal entanglement during this survey. The Groundfish Bottom Trawl Survey will add video cameras to the trawl net for the purpose of identifying fish and studying fish behavior as they enter the net but it may also provide information on unseen interactions of marine mammals with the research gear. The NWFSC also proposes a series of improvements to its protected species training, awareness, and reporting procedures under Alternative 2. These include a new program for its Chief Scientists and vessel captains to communicate with each other about their experiences with protected species interactions during research work with the goal of improving decision-making regarding avoidance of adverse interactions. Alternative 2 also includes new training requirements for all crew members on protected species protocols to formalize and standardize the information provided to all crew that might experience protected species interactions during research activities. Written cruise instructions, protocols, and information signage on the research vessel regarding avoidance of adverse interactions with protected species will be reviewed and, if found insufficient, made fully consistent with the protected species training materials and any guidance on decision-making that arises out of the two new training programs described above. The NWFSC expects these new gear modifications and procedures to facilitate and improve the implementation of the mitigation measures described under Alternative 1.

Alternative 3 includes the same mitigation measures as Alternative 2 but also includes a number of other potential mitigation measures that the NWFSC is not proposing to implement in its LOA application. These include a number of alternative methods for monitoring for protected species (e.g., use of dedicated Protected Species Observers, night-vision goggles and passive acoustic devices for periods of low visibility), gear modifications such as a camera or underwater video system to monitor any interactions of protected species with all trawl gear, and aircraft, unmanned aerial vehicles, or autonomous underwater gliders to provide additional detection capabilities. The analysis describes how these potential mitigation measures could reduce adverse impacts to marine mammals. However, some of these additional mitigation measures would have limited or no utility for mitigation, would have a serious adverse impact on the ability of the NWFSC to collect certain kinds of research data, would compromise the scientific

value of time-series data, and would have prohibitive impacts on the cost of research and therefore greatly reduce the scope of research that could be conducted. Some concepts and technologies considered in Alternative 3 are promising as a means to reduce risks to marine mammals and NMFS will evaluate the potential for implementation if they become more practicable.

Under the No Research Alternative, no direct adverse impacts to marine mammals from NWFSC-affiliated fisheries research (i.e., takes by gear interaction and acoustic disturbance) would occur. However, many of the NWFSC research projects that would be eliminated under this alternative contribute valuable ecological information important for marine mammal management, especially for ESA-listed species and stocks considered depleted under the MMPA. The loss of information on marine mammal habitats would indirectly affect resource management decisions concerning the conservation of marine mammals, especially as time went on and uncertainty about the status of the marine environment increased. There are too many unknown variables to estimate the specific effects this lack of information could have on any particular stock of marine mammals but the No Research Alternative would likely have minor adverse effects for the foreseeable future.

4.6.5 Summary of Effects to Birds

The effects of NWFSC fisheries research on seabirds include the potential for injury and mortality in fishing gear and ship strikes, changes in food availability, and contamination or degradation of habitat. All three of the research alternatives include the use of fishing gear (i.e., trawls, seines, and longlines) that have had substantial incidental catch of seabirds in commercial fisheries of the Pacific. However, research gear is generally smaller than commercial gear and research protocols are quite different than commercial fishing practices. In particular, fisheries research uses much shorter duration trawls/sets than commercial fisheries and no bait/offal is thrown overboard while research gear is in the water, thereby greatly reducing the attraction of seabirds to research vessels. From 2002 through 2014 a total of 20 seabirds of five species have been killed during NWFSC research activities in the CCRA, all during the Juvenile Salmon PNW Coastal Survey using a Nordic 264 surface trawl. The takes consisted of 14 common murrelets, two tufted puffins, two rhinoceros auklets, and one each of Cassin's auklet and sooty shearwater. NWFSC research activities in the PSRA and LCRRA have no history of taking seabirds. The magnitude of these incidental takes are considered minor under Alternatives 1 and 2. The overall risk of NWFSC fisheries research causing changes in food availability for seabirds or contamination in the marine environment detrimental to seabirds is considered minor adverse.

One potential mitigation measure under Alternative 3 would be for the NWFSC to deploy streamer lines on longline gear to reduce the risk of catching seabirds. If seabird interactions with NWFSC longline gear are documented in the future, the NWFSC will evaluate whether use of streamer lines is warranted given the tradeoffs between the potential conservation benefit and changes to research protocols that might affect time-series data.

Some NWFSC surveys take bird biologists on board when there is bunk space available to conduct transect surveys for bird distribution and abundance in the CCRA. This information is used by NMFS, the U.S. Fish and Wildlife Service, and other international resource management agencies to help with bird conservation issues and is considered to have indirect beneficial effects on birds.

Under the No Research Alternative, the risk of direct adverse effects on seabirds from NWFSC research would be eliminated, but there could be potential long-term minor adverse indirect impacts to seabirds because resource management authorities would lose ecological information about the marine environment important to seabird conservation.

4.6.6 Summary of Effects to Sea Turtles

The DPEA analyzes the same direct and indirect effects of NWFSC fisheries research on sea turtles as described for marine mammals. The potential for ship strikes, removal of prey, and contamination of marine habitat would be similar to the risks described for marine mammals; these effects are considered minor adverse for all species under all three research alternatives. Sea turtles hearing range is apparently well below the frequencies of acoustic instruments used in fisheries research so turtles are unlikely to detect these sounds or be affected by them. The NWFSC has no history of interactions with sea turtles in research gear and the potential for injury or mortality under all of the research alternatives is very small. The overall effects of the research alternatives would therefore be considered minor adverse on all species of sea turtles.

As with marine mammals and seabirds, the No Research Alternative would eliminate the risk of direct adverse effects on sea turtles from NWFSC research. However, there could be minor adverse indirect impacts due to the loss of NWFSC-affiliated research on bycatch reduction and ecological information important to sea turtle conservation.

4.6.7 Summary of Effects on Invertebrates

The NWFSC conducts stock assessment and habitat research for several important invertebrate species (i.e., ocean pink shrimp and market squid) that are important for commercial and recreational fisheries. The scope and methodologies used to assess these stocks would be similar for all three research alternatives. For all invertebrate species targeted by commercial fisheries and managed under FMPs, mortality due to NWFSC research surveys and projects is less than two percent of commercial harvest and is considered to be minor in magnitude for all species (Table 4.2-19). The footprint of bottom trawl gear used in research is also relatively small in magnitude and impacts to benthic infauna and epifauna would be temporary. The NWFSC conducts research in several areas closed to commercial fishing with bottom trawl gear, but much of this effort is the primary means for NMFS to monitor the recovery of groundfish stocks, benthic habitat, and the efficacy of fisheries conservation measures. Under the three research alternatives, minor adverse impacts to invertebrates are expected from NWFSC research activities. NWFSC research is also important for the scientific and sustainable management of these valuable fisheries, helping to prevent overfishing on the stocks, and therefore has beneficial indirect effects on the species.

As described for effects on fish, another difference between the research alternatives concerning invertebrates is the potential for spatial/temporal restrictions under Alternative 3, which could reduce overall research effort or cause changes in specific locations where that research occurs or when it occurs. Without further details on such restrictions, it is assumed that overall effects on invertebrates would be very similar to Alternatives 1 and 2.

Under the No Research Alternative, direct adverse impacts to invertebrates would be eliminated. As was the case with commercially important fish species, the loss of stock assessment and marine environment information could indirectly result in minor to moderate adverse effects on commercially targeted invertebrate species through increasing uncertainty in the fishery management process.

4.6.8 Summary of Effects on the Social and Economic Environment

The effects of NWFSC fisheries and ecosystem research on the social and economic environment are expected to be very similar under all three research alternatives. Each of these alternatives would include important scientific contributions to sustainable fisheries management for valuable commercial, tribal, and recreational fisheries along the U.S. West Coast, which benefits the communities and tribes that support them. These industries have large economic footprints, generate billions of dollars' worth of sales and thousands of commercial fishing-related jobs, and provide millions of people across the country with

highly valued seafood. Millions of recreational fishers also participate and support fishing service industries. NWFSC fisheries research activities would also have minor to moderate beneficial impacts to the economies of fishing communities through direct employment, purchase of fuel, vessel charters, and supplies. Continued NWFSC fisheries research is important to build trust and cooperation between the fishing industry, tribes, and NMFS scientists and fisheries managers. The overall effects of NWFSC-affiliated research would be long-term, distributed widely across the West Coast region, and would be considered minor to moderately beneficial to the social and economic environment for all three research alternatives.

The impacts of the No Research Alternative would be the inverse of the three research alternatives. It would likely have minor to moderate adverse impacts on the social and economic environment through greater uncertainty in fisheries management, which could lead to more conservative fishing quotas (i.e., underutilized stocks and lost opportunity) or an increased risk of overfishing, followed by reductions in commercial and recreational fisheries harvests. These impacts would adversely affect the ability of NMFS to comply with its obligations under the MSA. It would also eliminate research-associated federal spending on charter vessels, fuel, supplies, and support services in various communities. The No Research Alternative would also have long-term adverse impacts on the scientific information the NWFSC contributes to meet U.S. obligations for living marine resource management under international treaties.

5.1 INTRODUCTION AND ANALYSIS METHODOLOGY

The Council on Environmental Quality (CEQ) defines cumulative impact as:

“The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time” (40 Code of Federal Regulations [CFR] 1508.7).

Cumulative effects are assessed by aggregating the potential direct and indirect effects of the proposed action with the impacts of past, present, and reasonably foreseeable future actions in the vicinity of the project. The ultimate goal of identifying potential cumulative effects is to provide for informed decisions that consider the total effects (direct, indirect, and cumulative) of the project alternatives. As suggested by the CEQ handbook, *Considering Cumulative Effects Under the National Environmental Policy Act* (1997), the following basic types of cumulative effects are considered:

- Additive – the sum total impact resulting from more than one action,
- Countervailing – adverse impacts that are offset by beneficial impacts, and
- Synergistic – when the total impact is greater than the sum of the effects taken independently.

Cumulative effects may result from the incremental accumulation of similar effects or the synergistic interaction of different effects. Repeated actions may cause effects to build up over time, or different actions may produce effects that interact to produce cumulative impacts greater than (or less than) the sum of the effects of the individual actions.

As directed by CEQ’s National Environmental Policy Act (NEPA) regulations (40 CFR 1502.16), this chapter discusses direct and indirect impacts on specific physical, biological, and social resources in combination with varying levels of effects, ranging from minor to major. While the effects of individual actions may be only minor, substantial cumulative effects may result from multiple actions occurring in the same geographic area. The implementing regulations of NEPA require analysis of cumulative effects in order to alert decision makers of the full consequences of all actions affecting a resource component and assess the relative contribution of the proposed action and alternatives.

Chapter 3 of this Draft Programmatic Environmental Assessment (DPEA) provides baseline information on the physical, biological, and social components of the environment that may be affected by Northwest Fisheries Science Center (NWFSC) research activities. Chapter 4 provides an analysis of the direct and indirect effects on these resources of the four alternatives considered in this DPEA. Because the first three alternatives involve the continuation of NWFSC research activities (referred to collectively as the research alternatives) and contribute similar effects to the cumulative effects on most resources, they are generally considered together in the following Chapter 5 analysis. The contribution of the No Research Alternative to cumulative effects is quite different and is considered separately for each resource.

5.1.1 Analysis Methodology

The cumulative effects analysis methodology is similar to the effect assessment methodology for direct and indirect effects in Section 4.1. It consists of the following steps:

1. Define the geographic area and timeframe. These may vary between resource components.

2. Identify external actions¹², including:
 - a. Past actions that have already occurred and resulted in lasting effects (see Chapter 3),
 - b. Present actions occurring within the same timeframe as the proposed action and alternatives (see Chapter 3), and
 - c. Reasonably foreseeable future actions (RFFAs), which are planned and likely to occur (see Table 5.1-1).
3. Evaluate the direct and indirect effects of the proposed action and alternatives along with the adverse and beneficial effects of external actions and rate the cumulative effect using the effects criteria table (Table 4.1-1).
4. Assess the relative contributions of the alternatives to the cumulative effects.

5.1.2 Geographic Area and Timeframe

This cumulative effects analysis considers external actions that influence the geographic areas where NWFSC-affiliated research activities occur. Some actions that originate outside of the NWFSC research areas, such as discharge of pollutants, or actions that influence populations of highly migratory species, could potentially contribute to cumulative effects within the geographic areas of interest; such actions are considered in the analysis of cumulative effects. Other actions considered in the analysis of cumulative effects may be geographically widespread, such as those that could potentially result in climate change or ocean acidification. Although discussions of past actions primarily focus on the last five years, the availability of existing information and the period of time that must be considered to understand the baseline conditions vary between resource components. All analyses project at least five years into the future from the date this DPEA is finalized.

5.1.3 Reasonably Foreseeable Future Actions

Table 5.1-1 summarizes the RFFAs external to NWFSC fisheries research that are likely to occur in the next five years and the resources they are likely to affect. This information has been collected from a wide variety of sources, including recent NEPA documents covering the Northwest marine environment, federal and state fishery agency websites and documents, United States (U.S.) Navy websites and documents, and a variety of documents concerning industrial developments such as Liquefied Natural Gas import terminals, offshore wind farms, ocean current energy projects, dredging, and ocean disposal. Wildlife management documents such as endangered species recovery plans and take reduction plans for sea turtles and marine mammals were also consulted to identify conservation concerns for different species and habitats.

Deciding whether to include actions that have already occurred, are ongoing, or are reasonably foreseeable in the cumulative impacts analysis depends on the resource being analyzed. Past, ongoing, and future actions must have some known or expected influence on the same resources that would be affected by the alternatives to be included in the cumulative impacts analysis. CEQ refers to this as the cause-and-effect method of connecting human activities and resources or ecosystems. The magnitude and extent of the effect of an action on a resource or ecosystem depends on whether the cumulative impacts exceed the capacity of the resource/ecosystem to sustain itself and remain productive over the long-term.

¹² External actions are human activities other than NWFSC-affiliated fisheries research activities and natural occurrences that have resulted or will result in effects to the resource components that comprise the affected environment.

CEQ guidelines state that “it is not practical to analyze cumulative effects of an action on the universe; the list of environmental effects must focus on those that are truly meaningful.” In general, actions can be excluded from the analysis of cumulative impacts if:

- The action is outside the geographic boundaries or time frame established for the cumulative impacts analysis.
- The action will not affect resources that are the subject of the cumulative impacts analysis.
- The action is not planned or is not reasonably foreseeable (e.g., formally proposed, planned, permitted, authorized, or funded).

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Table 5.1-1 Reasonably Foreseeable Future Actions related to NWFSC Research Areas

Blank cells indicate no effects on that resource.

Action	NWFSC Research Areas			Effect on Physical Environment	Effect on Special Resource Areas	Effect on Fish	Effect on Marine Mammals	Effect on Seabirds	Effect on Sea Turtles	Effect on Invertebrates	Effect on Social and Economic Environment
	California Current	Puget Sound	Lower Columbia River								
Other Scientific Research (non-NWFSC-affiliated)	X	X	X	Presence of additional vessel traffic Sea floor disturbance Generation of Marine debris	Habitat disturbance Contamination (Spills, Discharges)	Habitat disturbance Removal of individuals and biomass Behavioral disruptions	Behavioral displacement Loss/injury from ship strikes Noise responses	Loss from avian by-catch Potential for ship collisions (lighting attraction)	Loss/injury from ship strikes	Loss or displacement due to habitat disturbance Removal of individuals and biomass	Increased understanding of environment leading to better resource management
Liquid Natural Gas (LNG) terminal	X (several proposed)	X (one proposed on Vancouver Island)	X (two proposed along the Columbia River; one at the mouth)	Increased turbidity (construction phase) Sea floor disturbance Presence of additional vessel traffic Provision of new underwater structures	Contamination Increased turbidity Sea floor disturbance	Loss/injury from contamination Construction related habitat disturbance Provision of new structured habitat Contamination of fish for human consumption	Loss/injury from ship strikes Noise effects (construction, vessel) Behavioral disturbance Loss/injury from contamination Loss/injury due to ingestion/entanglement in marine debris Loss/injury due to entanglement in buoy chains Alteration or reduction of prey resources	Loss/injury from contamination Loss from structure or ship collision (lighting attraction) Loss/injury due to ingestion/entanglement in marine debris Alteration or reduction of prey resources	Loss/injury from ship strikes Noise effects (construction, vessel) Behavioral disturbance Loss/injury from contamination Loss/injury due to ingestion/entanglement in marine debris Alteration or reduction of prey resources	Habitat disturbance Increased risk from invasive species due to long-distance shipping activity Loss/injury from contamination Creation of new hard substrate habitats on structures	Fishing exclusion zones may displace fisheries Provision of new jobs Increased capacity for inexpensive fuel transport and handling
Oil and Gas Exploration, Development, and Extraction	X (southern CA only)			Increased turbidity (construction phase) Sea floor disturbance	Contamination Increased turbidity Sea floor disturbance	Loss/injury from contamination Habitat disturbance Contamination of fish for human consumption	Loss/injury from ship strikes Noise effects (construction, vessels) Behavioral disturbance Loss/injury from contamination Alteration or reduction of prey resources	Loss/injury from contamination Loss from structure or ship collision (lighting attraction) Alteration or reduction of prey resources	Loss/injury from ship strikes Noise effects (construction, vessel) Behavioral disturbance Loss/injury from contamination Loss/injury due to ingestion/entanglement in marine debris Alteration or reduction of prey resources	Habitat disturbance Loss/injury from contamination	Fishing exclusion zones may displace fisheries Provision of new jobs

Action	NWFSC Research Areas			Effect on Physical Environment	Effect on Special Resource Areas	Effect on Fish	Effect on Marine Mammals	Effect on Seabirds	Effect on Sea Turtles	Effect on Invertebrates	Effect on Social and Economic Environment
	California Current	Puget Sound	Lower Columbia River								
Vessel Traffic (Shipping)	X	X	X	Contamination of water and sediment	Increased risk from invasive species due to long-distance shipping activity Contamination	Loss due to competition or predation from invasive species Loss/injury from contamination Noise effects (stress, altered behavior)	Loss/injury from ship strikes Displacement Noise effects (stress, altered behavior) Behavioral disturbance Loss/injury due to ingestion/entanglement in marine debris	Loss/injury from contamination Noise effects (stress, altered behavior) Loss/injury due to ingestion/entanglement in marine debris Ship collision (lighting attraction)	Loss/injury from contamination Noise effects (stress, altered behavior) Loss/injury due to ingestion/entanglement in marine debris	Loss due to competition or predation from invasive species Loss/injury from contamination	Provision of jobs and economic opportunity
Vessel Traffic (Other)	X	X	X	Contamination of water and sediment	Increased risk from invasive species due to long-distance shipping activity Contamination	Loss due to competition or predation from invasive species Loss/injury from contamination Noise effects (stress, altered behavior)	Loss/injury from ship strikes Displacement Noise effects (stress, altered behavior) Behavioral disturbance Loss/injury due to ingestion/entanglement in marine debris	Loss/injury from contamination Noise effects (stress, altered behavior) Loss/injury due to ingestion/entanglement in marine debris Ship collision (lighting attraction)	Loss/injury from contamination Noise effects (stress, altered behavior) Loss/injury due to ingestion/entanglement in marine debris	Loss due to competition or predation from invasive species Loss/injury from contamination	
Ocean Disposal and Discharges	X	X	X	Sea floor disturbance Sedimentation	Contamination Disturbance of benthic habitats Sea floor disturbance Sedimentation	Bioaccumulation of contaminants Loss/injury from contamination Habitat disturbance	Bioaccumulation of contaminants Loss/injury from contamination Loss/injury from ship strike Alteration or reduction of prey resources Habitat disturbance	Bioaccumulation of contaminants Loss/injury from contamination Alteration or reduction of prey resources Habitat disturbance	Bioaccumulation of contaminants Loss/injury from contamination Alteration or reduction of prey resources Habitat disturbance	Bioaccumulation of contaminants Loss/injury from contamination Habitat disturbance	Potential indirect impact on subsistence resources
Dredging	X	X	X	Sea floor disturbance Increased turbidity	Sea floor disturbance Increased turbidity	Loss of habitat due to sea floor disturbance Displacement due to turbidity	Noise effects (stress, altered behavior) Loss/injury from ship strikes Habitat disturbance/alteration Alteration or reduction of prey resources	Noise effects (stress, altered behavior) Habitat disturbance/alteration Alteration or reduction of prey resources	Mortality by entrainment in dredge Habitat disturbance/alteration	Direct loss or displacement due to bottom trawling Indirect loss or displacement due to habitat disturbance Loss/displacement due to turbidity	
Geophysical/ Geotechnical Activities				Sea floor disturbance	Sea floor disturbance	Habitat disturbance Noise effects from acoustic surveys	Noise effects from acoustic surveys Loss/injury from ship strikes Behavioral disturbance	Potential for loss due to ship collisions (lighting attraction) Behavioral disturbance	Loss/injury from ship strikes Behavioral disturbance	Habitat disturbance Localized benthos disturbance	

Action	NWFSC Research Areas			Effect on Physical Environment	Effect on Special Resource Areas	Effect on Fish	Effect on Marine Mammals	Effect on Seabirds	Effect on Sea Turtles	Effect on Invertebrates	Effect on Social and Economic Environment
	California Current	Puget Sound	Lower Columbia River								
Sea Turtle Conservation Measures	X	X	X						Decreased serious injury and mortality		Cost to fisheries, gear modifications
Marine Mammal Conservation Measures	X	X	X				Decreased serious injury and mortality				Cost to fisheries Displacement of personnel from fishing and other marine activities Need for time/area closures
Climate Change	X	X	X	Sea level rise, saltwater infusion in estuaries and coastal habitats Increased erosion and siltation Increased water temperatures More extreme storm events	Sea level rise, saltwater infusion in estuaries and coastal habitats Increased erosion and siltation Increased water temperatures More extreme storm events	Unknown ecosystem level changes, variable effects on different species	Unknown ecosystem level changes, variable effects on different species	Unknown ecosystem level changes, variable effects on different species	Unknown ecosystem level changes, variable effects on different species	Unknown ecosystem level changes, variable effects on different species	Rising water levels in coastal areas Potential changes in fisheries due to ecosystem changes New regulations on greenhouse gas emissions Incentives for higher vessel fuel efficiency
Ocean Acidification	X	X	X	Increased pCO ₂ Decreased pH	Decreased calcification among food web organisms Change in primary production	Potential adverse effects on prey, availability of nutritional minerals Potential direct adverse effects on growth, reproduction, development	Potential adverse effects on prey, availability of nutritional minerals	Potential adverse effects on prey, availability of nutritional minerals	Potential adverse effects on prey, availability of nutritional minerals	Decreased calcification, shell hardening impaired Potential adverse effects on prey, availability of nutritional minerals	Potential effects on fisheries, especially for invertebrate species
Dams		X	X	Alteration of water flow, velocity, temperature, dissolved gas content, and elevation		Blocks migration and dispersal. Reduces access to habitat.	Concentrates prey species Affects movement	Concentrates prey species Affects availability of prey species upstream	Affects movement, availability of prey species	Affects movement	Provision of jobs and economic opportunity Provision of recreational opportunities. Protection from flooding. Provision of
Agriculture		X	X	Contamination of water and sediment Increased water temperature from removal of riparian habitat		Potential direct adverse effects on prey availability reproduction, development	Potential direct adverse effects on prey availability	Potential direct adverse effects on prey availability	Potential direct adverse effects on prey availability	Degradation of water quality	Provision of jobs and economic opportunity Provision of food

Action	NWFSC Research Areas			Effect on Physical Environment	Effect on Special Resource Areas	Effect on Fish	Effect on Marine Mammals	Effect on Seabirds	Effect on Sea Turtles	Effect on Invertebrates	Effect on Social and Economic Environment
	California Current	Puget Sound	Lower Columbia River								
Forestry		X	X	Contamination of water and sediment Increased water temperature from removal of riparian habitat		Potential direct adverse effects on prey availability reproduction, development. Reduction in spawning and rearing habitat.	Potential direct adverse effects on prey availability	Potential direct adverse effects on prey availability	Potential direct adverse effects on prey availability	Degradation of water quality	Provision of jobs and economic opportunity Provision of wood products
Wave/Tidal Power Plants	X (planned)	X (planned)		Modification of localized sediment transport		Modification of hydrodynamics that may affect behavior. Noise levels may cause behavioral changes.	Modification of hydrodynamics that may affect behavior. Noise levels may cause behavioral changes. Potential disruption or impairment of essential behavior patterns or migrations in fish or marine mammals due to electromagnetic fields (EMF) and increased noise;	Potential injury or direct mortality due to contact with the turbines or marine debris entanglement.	Potential injury or direct mortality due to contact with the turbines or marine debris entanglement.	Potential to alter localized marine benthic habitats due to changes in hydrodynamics	Provision of jobs and economic opportunity Provision of electrical power.
Coal Terminals		X (Proposed - Cherry Point in Puget Sound)	X (Proposed - Port of Morrow on Columbia River	Seafloor disturbance Increased turbidity (construction phase)		Construction related habitat disturbance	Noise effects (construction, vessel) Loss/injury from ship strikes Behavioral disturbance	Loss from structure or ship collision (lighting attraction)	Loss/injury from ship strikes Noise effects (construction, vessel) Behavioral disturbance Loss/injury from contamination	Habitat disturbance Increased risk from invasive species due to long-distance shipping activity Loss/injury from contamination Creation of new hard substrate habitats on structures	Provision of jobs and economic opportunity
Bridges			X (Proposed - Columbia River Crossing)	Seafloor disturbance Increased turbidity (construction phase)		Construction related habitat disturbance	Noise effects (construction, bridge use) Behavioral disturbance	Behavioral disturbance	Noise effects (construction, bridge use) Behavioral disturbance	Habitat disturbance Creation of new hard substrate habitats on structures	Provision of jobs and economic opportunity

California Energy Commission 2011. West Coast LNG Projects and Proposals
US Navy 2008. Northwest Training Range Complex Draft Environmental Impact Statement/Overseas Environmental Impact Statement
BOEM. 2012. Outer Continental Shelf Oil and Gas Leasing Program: 2012-2017, Final Programmatic Environmental Impact Statement. OCS EIS/EA BOEM2012-030. U.S. Dept of the Interior, Bureau of Ocean Energy Management.
FERC 2013 Environmental Assessment for Hydropower Pilot Project License, Admiralty Inlet Tidal Pilot Project

5.2 CUMULATIVE EFFECTS ON THE PHYSICAL ENVIRONMENT

Activities external to NWFSC fisheries research that could potentially affect the physical environment within the CCRA, PSRA, and LCRRA may include commercial and recreational fisheries, ocean disposal and discharges, dredging, coastal development, dams, agriculture, forestry, other scientific research, military operations, climate change, and ocean acidification. The potential effects of these activities are summarized in Table 5.1-1 and include:

- Sea floor disturbance
- Increased turbidity and re-suspension of sediments
- Presence of new underwater structures
- Effects of climate change such as increased water temperatures and sea level rise

5.2.1 External Factors in the NWFSC Research Areas

The physical environment of the CCRA, PSRA, and LCRRA has been affected by human activity since humans first settled into the Pacific Northwest region. Until recent times, however, the magnitude of the effects was limited. With the advent of substantial offshore development and exploitation of resources from the ocean environment in the CCRA, cumulative impacts on the physical environment have increased. Similarly, dams, increased agriculture and forestry practices, and the construction of bridges have contributed to increased cumulative impacts in both the PSRA and LCRRA. Within all of the NWFSC research areas, the physical environment continues to experience impacts resulting from both natural and anthropogenic factors, including climate change, ocean acidification, seafloor disturbance from commercial fisheries, contamination from spills and discharges, presence of vessel traffic, marine debris, and new resource development projects. Sources of effects to the physical environment from RFFAs are identified in Table 5.1-1.

Past activities that disturbed the seafloor were generally limited to commercial fishing activities, U.S. naval testing activities, the laying of underwater cables for communications systems, offshore oil and gas exploration and development, and other resource development projects. Current activities that disturb the seafloor within all of the NWFSC research areas include not only more modernized commercial fishing (mainly trawling and dredging), but other heavy industrial activities such as channel dredging. Oil and gas exploration, development, and extraction continue to disturb the seafloor within the CCRA, and tend to have longer-term effects but affect smaller areas. Activities such as dams, agriculture, forestry, and bridges affect all three research areas to various extents. These activities cause re-suspension of sediments into the water column, changes in bathymetric contours, and permanent loss of benthic habitat. Proposed development projects such as LNG plants within all of the NWFSC research areas have the potential for long-term effects, but impacts would likely be limited to the areas immediately adjacent to the projects. Such projects would be evaluated for environmental effects, including cumulative effects, before they would be permitted by the appropriate federal agencies.

Contamination from spills and discharges can accumulate in the seafloor and marine life and have a toxic effect on the plants, animals and humans through the food chain (NOAA 2010c). Spills and discharges from both commercial and recreational fisheries can also accumulate and affect estuarine and riverine plants and animals throughout the NWFSC research areas. Contaminants from these external activities can transfer through the food web and impact ESA-listed salmon stocks in the lower Columbia River (Nilsen and Morace 2014). There are huge numbers of potential sources of both direct and indirect marine contamination, including tankers and other marine vessels, military operations, ocean dumping, airborne deposition, and runoff from industrial and agricultural sources on land. Some chemical compounds, such as polychlorinated biphenyl (PCB) and pesticides, can persist for many years while others, such as

petroleum products, breakdown relatively quickly. In a similar situation, marine debris can affect the physical environment (NOAA 2010c) but most of these effects are manifested through biological systems, which are discussed in other sections of this document. Pollution is a long-term and widespread issue in the marine environment, although it varies substantially in intensity on a local basis. In recent years there has been a concerted national and international effort to reduce pollution of ocean environments through restrictions on discharges and design features of ocean-going vessels that reduce the probability and severity of spills. Broadly speaking therefore, the cumulative effects of pollution and contamination on water quality of the NWFSC research area is expected to be minor to moderate and adverse from sources external to fisheries research.

Climate change may affect the marine and riverine environment in a variety of ways, including changes in sea level, changes in water temperatures, extreme weather events, and alteration of ocean currents. Additionally, climate change may also alter stream flow into all three research areas through changes in winter runoff volumes (Hamlet and Lettenmaier 2007). These changes and others are expected to continue over the reasonably foreseeable future and could aggregate with the effects of industrial activity to impact the physical environment. These changes contribute in turn to changes in the population and distribution of marine fish, mammals, seabirds, and turtles; changes in the population and distribution of fishery resources harvested in commercial fisheries, with related socioeconomic effects; and changes in FMPs to address potential climate change effects.

In addition to changes in air and water temperatures, a related effect of climate change is increased acidification in the ocean caused by dissolved carbon dioxide (CO₂). Changes in the acidity of the world's oceans are expected to continue and accelerate over the reasonably foreseeable future (United States Geological Survey [USGS] 2011). Ocean acidification can harm organisms that build shells of calcium carbonate, including calcareous phytoplankton and zooplankton, corals, bryozoans, mollusks, and crustaceans. These organisms provide shellfish resources for humans, play vital roles in marine food webs, and add to the physical structure of the ocean floor (NEA 2010). Although the dynamics of climate change and the potential magnitude and timing of its effects are poorly understood, there is general acknowledgement that the potential impacts resulting from climate change could be substantial.

5.2.2 Contribution of the Research Alternatives

Direct and indirect effects of the research alternatives on the physical environment in the NWFSC research areas are discussed in sections 4.2.1, 4.3.1, and 4.4.1. Direct and indirect effects to benthic habitat (seafloor disturbance) and removal of organisms that produce structure would be minor and adverse. Since no ocean disposal or discharges would be authorized for NWFSC research activities under the research alternatives, there would be no contribution to cumulative effects from this action. There is the potential for accidental spills to occur. However, given the high degree of emphasis placed on safety and emergency preparedness on NOAA Corps vessels and Coast Guard requirements for training and safety equipment on commercial vessels, the magnitude of these potential spills is likely to be very small and the contribution of fisheries research to the cumulative effects of contamination is considered minor.

Although CO₂ emissions from NWFSC research vessels would contribute to atmospheric CO₂ levels, the contribution would be minor compared to other natural and anthropogenic CO₂ sources. When aggregated with the impacts of past, present, and reasonably foreseeable future actions in the vicinity of the NWFSC research areas, NWFSC research activities would make a minor additive contribution to cumulative adverse effects on the physical environment under each of the research alternatives.

Fisheries research programs contribute to the understanding of changes in the physical environment, including those associated with climate change and ocean acidification. Continued fisheries research programs with long-term data sets are essential to understanding changes in the physical and biological environment, and allowing NMFS to take appropriate management actions. Understanding changes in the physical environment that may affect ESA-listed salmon stocks (e.g. sediment dynamics and water

chemistry) within the marine environment is particularly useful. NWFSC fisheries research therefore makes a beneficial contribution to cumulative effects on the physical environment.

5.2.3 Contribution of the No Research Alternative

The No Research Alternative would eliminate the risk of direct adverse impacts to physical resources within the NWFSC research areas resulting from NWFSC research activities. However, many of the NWFSC projects that would be eliminated under this alternative generate a great deal of information that, when combined with research conducted by other branches of NOAA and other agencies and institutions not included in this DPEA, is used to monitor the effects of climate change, ocean acidification, and other changes in the physical environment. It may also be used by resource managers to limit fishing-related impacts to physical habitat such as disturbance of benthic habitat from bottom-contact gear. Without the input of NWFSC data, management authorities would lose important information needed to establish management measures in a meaningful fashion, and current conservation measures in place to protect physical properties of the environment would become less effective. Although resource management agencies have other available data sources to support resource management decisions, the No Research Alternative is expected to result in increased uncertainty and changes in some management scenarios. Through these indirect effects on future management decisions, the contribution of this alternative to adverse cumulative impacts on physical resources would be minor to moderate depending on how well other agencies would be able to compensate for the loss of NWFSC research.

5.3 CUMULATIVE EFFECTS ON SPECIAL RESOURCE AREAS

Activities external to NWFSC fisheries research that could potentially affect special resource areas in the Pacific include commercial and recreational fisheries, ocean disposal and discharges, dredging, coastal development, oil extraction, other scientific research, military operations, climate change, and ocean acidification. The potential effects of these activities are summarized in Table 5.1-1 and may include:

- Contamination resulting from spills or discharges
- Habitat disturbances
- Increased risk of invasive species introductions resulting from long-distance shipping activity
- Effects of climate change such as increased water temperatures and sea level rise
- Effects of ocean acidification such as decreased calcification among food web organisms and
- Changes in primary production

5.3.1 External Factors in the NWFSC Research Areas

As described in Section 3.2, Special Resource Areas include Essential Fish Habitat (EFH), Habitat Areas of Particular Concern (HAPC), Closed Areas, and Marine Protected Areas (MPAs), including National Marine Sanctuaries (NMS). The cumulative effects of activities that disturb the seafloor in special resource areas are similar to those discussed for the physical environment in Section 5.2.1. Cumulative impacts to biological resources within special resource areas are discussed in Sections 5.4 through 5.8. Cumulative effects from oil extraction, dredging, military operations, and geophysical exploration will be considered as part of the federal permitting process. Contributions to cumulative effects from such activities would be limited by permit conditions and mitigation measures required by permitting agencies. Effects of oil extraction are unique to the CCRA since there are no oil extraction projects occurring in the the LCRRA or the PSRA. Adverse impacts from commercial fishing operations, especially with bottom contact fishing gears, would be substantial in heavily fished areas and would affect EFH and HAPC areas to various degrees, but would not be as great in permanent closed areas or some marine reserves that are closed to commercial fishing. In some cases, closed areas have been designated to allow the recovery of areas that were heavily affected by commercial fisheries in the past. The identification of groundfish EFH in the NWFSC research area has resulted in over 400 distinct areas that extend across California, Washington, and Oregon. To mitigate adverse effects from fishing on groundfish EFH the PFMS has identified areas that are closed to fishing with specified gear types, or are only open to fishing with specific gear types. These locations include five bottom trawl closed areas off of Washington, nine off of Oregon, and 20 off of California. Descriptions of specific prohibited gear types by area are described in detail in section 3.1.2.1. In addition to the NWFSC, the Southwest Fisheries Science Center (SWFSC) also conducts fisheries research in the CCRA. In instances where the research activities of multiple science centers overlap in space and time, impacts resulting from those activities would accumulate in an additive or synergistic fashion. The cumulative effect from all external sources of disturbance to special resource areas is expected to be minor adverse.

The contribution of NWFSC research to the cumulative effects of marine contaminants in special resource areas are the same as those discussed for the physical environment in Section 5.2.3 and are considered minor adverse.

5.3.2 Contribution of the Research Alternatives

Direct and indirect effects of the research alternatives on special resource areas in the Pacific are discussed in sections 4.2.2, 4.3.2, and 4.4.2. A relatively small amount of fisheries research using bottom contact gear would occur in most special resource areas under the research alternatives, resulting in a

minor adverse contribution to the cumulative effects on these areas. When aggregated with the impacts of past, present, and reasonably foreseeable future actions in the vicinity of the project, NWFSC research activities would make a minor additive contribution to cumulative adverse impacts to special resource areas in the CCRA, PSRA, and LCRRRA under each of the research alternatives. While there are no intentional discharges of pollutants from fisheries research vessels there is potential for accidental spills to occur. However, the magnitude of these potential spills is likely to be very small and the contribution of fisheries research to the cumulative effects of contamination is considered minor.

NWFSC fisheries research programs contribute to understanding the status of special resource areas, including changes to EFH associated with climate change and ocean acidification as well as the recovery of closed area habitats from fishing. Continued fisheries research programs with long-term data sets are essential to understanding changes in the physical and biological environment within special resource areas, which by definition have special management needs. NWFSC fisheries research therefore has a beneficial contribution to cumulative effects on special resource areas in addition to the minor adverse effects.

5.3.3 Contribution of the No Research Alternative

The No Research Alternative would result in elimination of any direct impacts from NWFSC fisheries research to special resource areas that could potentially occur under each of the research alternatives. However, the NWFSC research activities proposed under the research alternatives would generate information important to resource managers to monitor species and habitat recovery, environmental changes, and the effectiveness of conservation measures for special resource areas. This type of information is especially important for management of special resource areas designated to protect and conserve natural resources that are susceptible to natural fluctuations and anthropogenic impacts. Although resource management agencies have other available data sources to support resource management decisions, the No Research Alternative is expected to result in increased uncertainty and changes in some management scenarios that may affect a few local areas. Through these indirect effects on future management decisions, the contribution of this alternative to cumulative impacts on special resource areas, including National Marine Sanctuaries, would be minor adverse.

5.4 CUMULATIVE EFFECTS ON FISH

Activities external to NWFSC fisheries research that could potentially affect fish species in the CCRA, PSRA, and LCRRRA may include commercial (including Treaty Indian fisheries) and recreational fisheries, ocean disposal and discharges, dredging, coastal development, dams, coastal agriculture/logging, other scientific research, military operations, vessel traffic, climate change, and ocean acidification. These activities and potential effects are summarized in Table 5.1-1 and include:

Injury or mortality due to directed catch or bycatch in commercial (including Treaty Indian fisheries) and recreational fisheries

- Habitat disturbances
- Behavioral disturbances
- Migration blockage or disruption
- Changes in distribution and food availability due to climate change or habitat degradation

5.4.1 California Current Research Area

5.4.1.1 Endangered Species Act (ESA)-listed Species

Several ESA-listed fish species occur in the CCRA (see Section 3.3.1.1 and Table 3.2-1) and are taken either intentionally (listed salmon research) or incidental to NWFSC fisheries research. Species taken in the CCRA (2008-2012) include Pacific eulachon and several ESA-listed ESUs of chinook, chum, and coho salmon, and DPSs of steelhead trout (Table 4.2-9).

External factors in the CCRA

The past, present, and reasonably foreseeable future activities that have or are likely to have the greatest effect on ESA-listed fish in the CCRA external to NWFSC fisheries research are intentional and incidental takes in commercial and recreational fisheries. Habitat alterations, especially for anadromous species, and periodic short-term and longer term climate changes may also affect population viability and stock sizes.

Habitat destruction, modification, or curtailment, and inadequate regulatory mechanisms are considered primary factors responsible for the decline of the southern DPS of Pacific eulachon (75 FR 13012). The federal recovery outline for Pacific eulachon identified 16 threats to eulachon; the top four in U.S. waters include by-catch, dams/water diversions, climate impacts on freshwater habitat, and ocean conditions (NMFS 2013d). Secondary threats include water quality, catastrophic events, disease, competition, shoreline construction or modification, tribal fisheries, invasive species, recreational and commercial fisheries, scientific monitoring, and dredging (Gustafson et al. 2010, NMFS 2013d).

Eulachon are taken as bycatch in shrimp trawl fisheries off the coasts of Washington, Oregon, California, and British Columbia (Gustafson et al. 2010 and citations therein). Combined estimated bycatch in the Washington, Oregon, and California pink shrimp fisheries was 1,075,081 eulachon in 2010. Highest estimated bycatch (741,202 fish) was off Oregon. All was assumed to be from the southern DPS (Al-Humaidhi et al. 2012). Beginning in 2003, bycatch reduction devices (BRDs) became mandatory in all U.S. West Coast shrimp trawl fisheries. The states of Oregon and Washington adopted rigid-gate BRD regulations in 2010 and 2012, respectively (NMFS 2013d).

Major threats and impacts to threatened and endangered Pacific salmonids include logging, agriculture, mining activities, urbanization, stream channelization, dams, wetland loss, water withdrawals, hydropower, and unscreened diversions (77 FR 19552). In addition, ocean-atmosphere climatic shifts

over decadal time scales (e.g., the Pacific Decadal Oscillation) may lead to decreased ocean productivity that exacerbates degraded freshwater habitat conditions important to salmon (NOAA 2014c). There is evidence of strong correlations between oceanic productivity “regimes” and salmon population abundance (Good et al. 2005 and citations therein).

Commercial and recreational fisheries are closed for coho salmon in California, but the Central California Coast coho salmon ESU may still be incidentally captured in fisheries for other species. The impacts of incidental bycatch are not well known (77 FR 19552). Commercial and recreational fisheries for Chinook and coho salmon in the PFMCM-managed waters along the U.S. West Coast (ocean fisheries between the U.S./Canada border and the U.S./Mexico border from 3 to 200 nm offshore) are responsible for the greatest direct removal of salmon in the area. In 2013, total commercial takes (Washington, Oregon, and California combined) were 500,110 individual Chinook salmon and 54,181 individual coho salmon. Recreational catch was 172,591 individual Chinook and 61,077 coho. Commercial takes include Treaty Indian fisheries (Pacific Fishery Management Council [PFMC] 2014).

The activities external to NWFSC fisheries research affecting ESA-listed fish will likely continue into the foreseeable future (see Table 5.1-1). The level of impact will depend on the application and efficacy of current and proposed mitigation measures. The potential effects of climate change are unpredictable, but are also likely to continue into and beyond the foreseeable future.

Contribution of the research alternatives

The three research alternatives considered in this DPEA include similar scopes of research in the NWFSC CCRA. The primary differences lie in the number and types of associated mitigation measures for protected species. The NWFSC does conduct directed research on ESA-listed fish species, and listed species have been taken incidentally in several surveys. In recent years, low levels of takes of Pacific eulachon were taken (147 kg) in the Bycatch Reduction Research Survey, Groundfish Bottom Trawl Survey, and in the Hake Acoustic Survey. No other ESA-listed non-salmonids were reportedly taken by NWFSC fisheries research during that time period.

Several ESA-listed ESUs of salmonids have been caught in NWFSC fisheries research in the CCRA. Many of these fish are sampled (with morphometric measurements taken and tags attached) and carefully released alive. No measureable population level effects are expected as a result of these takes, since they are small in comparison to ESU-specific population size estimates (Table 4.2-11 and Table 4.2-12).

When considered in conjunction with commercial and recreational fisheries and other external activities affecting ESA-listed fish in the CCRA, the NWFSC’s fisheries research contribution to cumulative effects would be considered minor adverse.

Contribution of the No Research Alternative

Under the No Research Alternative, NWFSC would no longer conduct or fund research in the CCRA, so would not directly contribute to cumulative effects on threatened and endangered fish species in this region. In the absence of research surveys, important scientific information would not be collected about the status of fish stocks used for fisheries and conservation management, including trends in abundance, recruitment rates, and the amount of fish being harvested relative to overfishing metrics. This lack of data would make it much more difficult for fisheries managers to effectively monitor the status of stocks, develop fishery regulations, and rebuild overfished stocks. NWFSC research also provides information on ecosystem characteristics important for monitoring potential effects from climate change and increases in ocean acidification, which could impact the population and distribution of many marine and anadromous species. The indirect effects of the No Research Alternative are uncertain and the magnitude of such effects would depend on the availability of alternative sources of data on ESA-listed fish and the marine environment from state agencies, academic institutions, tribal research cooperatives, and other research

entities. However, none of these alternative sources of data are likely to be able to replace the scope of work conducted by the NWFSC and this could result in adverse effects on ESA-listed fish stocks through a lack of information essential for informed decision making and conservation of fish, their prey, and habitats. The indirect contribution of the No Research Alternative to cumulative effects on any one species is difficult to ascertain, but would likely impact long-term monitoring and management capabilities for ESA-listed species, so would be considered minor to moderate adverse.

5.4.1.2 Target and Other Species

External factors in the CCRA

Target species are those managed for tribal, recreational, and commercial fisheries and the subject of NWFSC fisheries research. These fisheries are the primary past, present, and reasonably foreseeable future activities that have or are likely to have the greatest effect on these species in the CCRA external to NWFSC fisheries research. Natural population fluctuations and periodic short-term and longer term climate changes also affect population viability and stock sizes.

The numerous target species in the CCRA are managed through the PFMC and several fisheries management plans (FMPs) (Table 3.2-3). The analysis of effects in Chapter 4 focuses on those species most frequently caught (in quantities of 1 mt (1000 kg) or more) in NWFSC research activities and species that are considered overfished or rebuilding (Table 4.2-13). The cumulative effects analysis takes a similar approach.

The Pacific hake (whiting) fishery is the largest fishery along the West Coast from northern California to British Columbia, with long-term (1966-2013) average landings of 223,238 mt (Taylor et al. 2014). Recent (2010-2013) coast-wide landings exceeded this long-term average. Total landings (U.S. and Canada combined) in 2013 were 284,000 mt, 229,000 mt of which were U.S. landings. The 2014 female spawning biomass forecast is 1.72 million mt (Taylor et al. 2014). Since 2001, total catches have been below coast-wide Allowable Biological Catches (ABCs) (Stewart and Forrest 2011). Pacific hake is also the species caught in the greatest abundance during NWFSC fisheries research, with combined survey catches exceeding the next highest catches for other species by more than 1000 mt (Table 4.2-13).

Three of the target species encountered during NWFSC surveys are considered overfished (Table 4.2-13). This includes Pacific Ocean perch, canary rockfish, and yelloweye rockfish. Average yearly West Coast commercial catches of these species for 2008-2012 were 48 mt, 13.6 mt, and 3 mt, respectively. A stock that is overfished is one whose biomass level is sufficiently depleted to jeopardize the stock's ability to produce at Maximum Sustainable Yield (NMFS 2012a). Four previously overfished stocks (bocaccio, cowcod, petrale sole, and darkblotched rockfish) are no longer considered overfished and are rebuilding. Commercial catches for these rebuilding stocks averaged 7 mt, 3 mt, 1,358 mt, and 125 mt, respectively during 2008-2012. The remaining species and stocks are either of unknown status or not overfished (Tables 3.2-3 and 4.2-13).

The activities external to NWFSC fisheries research affecting target and other species will likely continue into the foreseeable future (see Table 5.1-1). The level of impact will depend on the application and efficacy of current and proposed mitigation measures and management schemes. The potential effects of climate variability are unpredictable, but are also likely to continue into and beyond the foreseeable future.

Contribution of the Research Alternatives

The average catch of target species during NWFSC research surveys in the CCRA (Table 4.2-13) is orders of magnitude smaller than most commercial and recreational harvest levels. For example, the NWFSC average annual catch of petrale sole (14.4 mt) is 1.1 percent of the 2008-2012 commercial

landings. Average annual research takes of Pacific halibut (8.3 mt) is the equivalent of 1.0 percent of the 2010 commercial landings. For most (65 percent) of the species listed in Table 4.2-13 for which commercial catch levels are known, research catch is less than two percent of commercial takes. For target species in the CCRA, mortality from NWFSC research surveys would be considered minor on the population level.

For a few species which do not have a large commercial market, such as certain minor rockfish species, spiny dogfish, and spotted ratfish, the research catch exceeds one percent of commercial catch (Table 4.2-13). For most of these species, commercial landings are greatly diminished from historical fisheries for various reasons. They currently do not have directed fisheries, so landings data do not reflect population status. NWFSC surveys, which are important for monitoring the stocks, catch a relatively higher proportion of the stock than marketable sized fish. The magnitude of research mortality for these species is very small relative to the estimated populations of these fish.

Other species caught by NWFSC surveys include stocks of some species that are considered overfished or overfishing is occurring, including canary rockfish, Pacific Ocean perch, and yelloweye rockfish (PSMFC 2012). Although research data is necessary for monitoring the status of these species and their habitats, research catch should be considered with other sources of mortality such as directed fishing, bycatch in other fisheries, and predation. Research catch levels for yelloweye rockfish is less than 1 percent of commercial landings, and therefore represent a very small relative magnitude of mortality. Research catch levels for Pacific Ocean perch (7.1 mt) and Canary rockfish (3.2 mt) are greater than 10 percent of commercial landings, which are restricted according to rebuilding Research catch levels for Pacific Ocean perch (7.1 mt) and Canary rockfish (3.2 mt) are greater than 10 percent of commercial landings, which are restricted according to rebuilding plans, but less than 1 percent of OFL for these stocks. plans, but less than 1 percent of ABC for these stocks. The magnitude of research mortality on these species would be minor relative to estimated biomass.

While mortality to target and other fish species is a direct effect of the NWFSC surveys, there are likely no measurable population changes occurring as a result of these research activities because they represent such a small percentage of fish taken in commercial and recreational fisheries, which are just fractions of the total populations for these species.

When considered in conjunction with commercial and recreational fisheries and other external activities affecting target and other species in the CCRA, the NWFSC's fisheries research contribution to cumulative effects would be minor adverse under all the research alternatives. NWFSC fisheries research also has beneficial contributions to fish species in the CCRA through its contribution to sustainable fisheries management decisions and would help to address a range of adverse cumulative effects.

Contribution of the No Research Alternative

Under the No Research Alternative, NWFSC would no longer conduct or fund research in the CCRA, so would not directly contribute to cumulative effects on target and other species in this region. However, NWFSC research provides the most reliable data for tracking the abundance and distribution of these stocks and thus provides critical information for monitoring their status and recovery.

In the absence of research surveys, important scientific information would not be collected about the status of fish stocks used for fisheries and conservation management, including trends in abundance, recruitment rates, and the amount of fish being harvested relative to overfishing metrics. This lack of data would make it much more difficult for fisheries managers to effectively monitor the status of stocks, develop fishery regulations, and rebuild overfished stocks. Ceasing or interrupting long-term data series on oceanography, abundance and distribution of various species, and diet studies would have long-term adverse effects on the ability of scientists to monitor and model effects of ecosystem changes. The lack of information and increasing uncertainty about the status of fish stocks and their habitats would have

substantial implications for fisheries management. The indirect effects of the No Research Alternative are uncertain and the magnitude of such effects would depend on the availability of alternative sources of data on target species and the marine environment from state agencies, academic institutions, tribal research cooperatives, and other research entities. However, none of these alternative sources of data are likely to be able to replace the scope of work conducted by the NWFSC and this could therefore result in adverse effects on target and other species through a lack of information essential for sustainable fisheries management. The indirect contribution of the No Research Alternative to cumulative effects on any one species is difficult to ascertain, but will likely impact long-term monitoring and management capabilities for numerous economically and ecologically important species and would therefore be considered minor to moderate adverse.

5.4.2 Puget Sound Research Area

5.4.2.1 Endangered Species Act (ESA)-listed Species

Several ESA-listed fish species occur in the PSRA, including five non-salmonids and six species of salmonids (see Section 3.3.1.1 and Table 3.2-1). Of these, the Puget Sound/Coastal DPS of bull trout, the Puget Sound/Georgia Basin DPS of canary rockfish, Puget Sound Chinook salmon, Hood Canal summer-run chum salmon, Puget Sound steelhead, and sockeye salmon were caught during NWFSC fisheries research in the PSRA between 2008 and 2012 (Table 4.2-9).

External factors in the PSRA

The past, present, and reasonably foreseeable future activities (external to NWFSC fisheries research) that have, or are likely to have, the greatest effect on ESA-listed fish in the PSRA are intentional and incidental takes in commercial and recreational fisheries. Habitat alterations, especially for anadromous species, and periodic short-term and longer term climate changes may also affect population viability and stock sizes.

Canary rockfish in Puget Sound/Georgia Basin exhibited an apparent steep decline in abundance, with decreasing frequency in catch data since 1965. This led the Biological Review Team to conclude that, combined with the overall rockfish decline in Puget Sound, the current trend greatly contributes to the extinction risk of this DPS (Drake et al. 2010). Additional concerns in Puget Sound include bycatch in commercial and recreational fisheries, construction, nearshore habitat loss, dredging, pollution and chemical contamination, areas of low dissolved oxygen, invasive species, habitat alterations from research activities, aquaculture, climate change and ocean acidification and downward trends in canary rockfish size (Drake et al. 2010, NMFS 2014b). Directed fishing for canary rockfish was prohibited in 2002, so no frequency data are available from the recreational fishery since then (Drake et al. 2010). Rocky habitat with which rockfish typically associate is limited in Puget Sound and subject to degradation by construction of bridges and other structures, laying cable and pipeline, and other seafloor disruptions. Ghost fishing by derelict fishing gear may also affect local populations of rockfish (Drake et al. 2010).

External threats facing bull trout in Puget Sound include upland and riparian habitat management (e.g., timber harvest, roads, urban development, agriculture), incidental catch in other fisheries, lack of forage fish, water quality (e.g., mining contaminants), invasive fish species, impaired water body connectivity, and a small population size (USFWS 2014). Habitat loss and fragmentation, interaction with invasive species, and issues with fish passage were considered the greatest threats affecting bull trout (USFWS 2008b).

Factors affecting bull trout in the PSRA similarly affect –or historically affected–salmon populations in the region. Included are timber harvest and agriculture impacts on watersheds and waterways, urbanization, nearshore, estuary, and marine habitat modification, and dams that impede access to historic

spawning habitat (Shared Strategy for Puget Sound 2005). The recent removal of the Elwha Dam and subsequent restoration of the natural river flow is leading to recovery of anadromous species in the river and other ecosystem functions. This recovery process is the subject of a major NWFSC research project.

Commercial and recreational fisheries are the biggest sources of direct take of Puget Sound Chinook salmon, although the fisheries are intended to catch non-ESA-listed fish. Chinook originating in Puget Sound are harvested in Puget Sound, off the Washington coast, as well as in Alaska and British Columbia (Shared Strategy for Puget Sound 2005). Hood Canal summer-run chum are not directly targeted, but are taken incidental to Chinook and coho fisheries (Shared Strategy for Puget Sound 2005). Total commercial harvest of Chinook in Puget Sound was 109,968 fish in 2013, which includes treaty Indian and non-Indian catch. Threatened Puget Sound Chinook were a small part of Washington coast harvest; PFMC ocean management is not directed at that stock (PFMC 2014c). Commercial net and troll harvest (treaty Indian and non-Indian) for all Puget Sound coho was 318,936 fish in 2013 (PFMC 2014c).

In addition to habitat, harvest, and hatcheries, climate change and fluctuating ocean conditions also affect Puget Sound salmonids and bull trout (Shared Strategy for Puget Sound 2005). Ocean-atmosphere climatic shifts over decadal time scales (e.g., the Pacific Decadal Oscillation) may lead to decreased ocean productivity that exacerbates degraded freshwater habitat conditions important to salmon (NOAA 2014c). There is evidence of strong correlations between oceanic productivity “regimes” and salmon population abundance (Good et al. 2005 and citations therein).

Contribution of the research alternatives

Listed non-salmonid species are rarely taken during NWFSC research activities (Table 4.2-10): only canary rockfish (22 individuals in 2012) have been taken; this level of mortality is considered negligible. There are no records of incidental catch of Pacific eulachon, yelloweye rockfish, Bocaccio, or green sturgeon during the 2008-2012 period, and no anticipated effects on any of these species.

ESA-listed salmonids taken during NWFSC research in the PSRA from 2008 through 2012 include: Hood Canal Summer-run ESU chum salmon, Chinook salmon of the Puget Sound ESU, sockeye salmon, and Puget Sound DPS of steelhead (Table 4.2-11). Bull trout are also taken rarely (157 in 2008 for an average of 40 individuals per year, 2008-2012). Many of these fish are sampled (with morphometric measurements taken and tags attached) and carefully released alive. Much of this research is covered under ESA section 10 permits which prescribe mitigation measures to reduce impacts on ESA-listed species and account for intentional (sampling) and unintentional mortality of fish. No measureable population level effects are expected as a result of these takes, since they are small in comparison to ESU and DPS size estimates (Table 4.2-11 and Table 4.2-12).

When considered in conjunction with commercial and recreational fisheries and other external activities affecting ESA-listed fish in the PSRA, the NWFSC’s fisheries research contribution to cumulative effects would be considered minor adverse.

Contribution of the No Research Alternative

Under the No Research Alternative, the NWFSC would no longer conduct or fund research in the PSRA, so would not directly contribute to cumulative effects on threatened and endangered fish species in this region. In the absence of research surveys, important scientific information would not be collected about the status of fish stocks used for fisheries and conservation management, including trends in abundance, recruitment rates, and the amount of fish being harvested relative to overfishing metrics. This lack of data would make it much more difficult for fisheries managers to effectively monitor the status of stocks, develop fishery regulations, and rebuild overfished stocks such as canary rockfish.

NWFSC research in the PSRA includes a study of steelhead smolt survival as well as ecosystem monitoring that provides information on ecosystem characteristics important for monitoring potential

effects from climate change and increases in ocean acidification, which could impact the population and distribution of many marine and anadromous species. The indirect effects of the No Research Alternative could, therefore, result in major adverse effects to fish stocks through a lack of information essential for informed decision making and conservation of fish, their prey, and their habitats. The indirect contribution of the No Research Alternative to cumulative effects on any one species is difficult to ascertain, but would likely impact long-term monitoring and management capabilities for ESA-listed species.

5.4.2.2 Target and Other Species

External factors in the PSRA

Target species are those managed for tribal, recreational, and commercial fisheries and the subject of NWFSC fisheries research. These fisheries are the primary past, present, and reasonably foreseeable future activities that have or are likely to have the greatest effect on these species in the PSRA external to NWFSC fisheries research. Natural population fluctuations and periodic short-term and longer term climate changes also affect population viability and stock sizes.

Target species in the PSRA are managed through the PFMC and several fisheries management plans (FMPs) (Table 3.3.1). The analysis of effects in Chapter 4 focuses on those species most frequently caught (measured in numbers of fish rather than weights, which are generally not applicable to juvenile fish). The cumulative effects analysis takes a similar approach.

Commercial fisheries are the primary activity impacting fish species in the PSRA and will likely continue into the foreseeable future. The level of impact will depend on the application and efficacy of current and proposed mitigation measures and management schemes. The 17 recognized tribes in Puget Sound, along with the State of Washington, jointly manage the fish and shellfish resources to ensure sustainable harvests. By treaty, tribal fishers collectively and non-tribal fishers collectively are entitled to up to one-half of the harvestable amount.

Fish in Puget Sound are also affected by ever-increasing human activity. In the Pacific Northwest, much of the population lives at the coastal interface of terrestrial and marine ecosystems, with an increasing trend in the coming decades (e.g., 1.4 million more residents are predicted in the Puget Sound region by 2020) (Puget Sound Regional Council 1995).

The health and productivity of many fish species in Puget Sound is a source of concern. For example, over the last two decades multiple salmon stocks have become extinct and healthy stocks have declined (Puget Sound Partnership 2013). A variety of fish species continue to show contamination by persistent, bioaccumulative toxic chemicals and estrogen disrupting compounds (Puget Sound Partnership 2013). Many factors have been highlighted as cause for deteriorating fish species including contamination, loss of river delta area and shoreline and tidal wetlands, elimination of coastal embayments, modifications to beaches and bluffs, simplified and shorter shorelines, habitat fragmentation, as well as over harvesting and the cumulative effect of widespread degradation (Fresh et al 2011).

Potential effects of climate variability are possible and are unpredictable, but are also likely to impact these species and to continue into the foreseeable future.

Contribution of the research alternatives

Most of the fish caught during NWFSC research in the PSRA are juvenile fish or forage fish species and many are released alive after careful processing. Most of the commercial and recreational catch in Puget Sound is targeted toward adult salmonids, bottomfish, and invertebrates, such as Dungeness crab and shrimp. Differences in size classes taken limit direct take comparisons. The amount of fish captured in Puget Sound research surveys is, however, considered minor for all species in the PSRA. The only

exception maybe the amount of listed juvenile salmonids captured. Effects on these ESA listed fish species are discussed above and are expected to be rare, short-term in frequency and duration, localized, and results in no measurable population level effects.

While mortality to target and other fish species is a direct effect of the NWFSC surveys, there are likely no measurable population changes occurring as a result of these research activities since they likely represent a small percentage of fish taken in commercial and recreational fisheries, which are just fractions of the total populations for these species.

When considered in conjunction with commercial and recreational fisheries and other external activities affecting target and other species in the PSRA, the NWFSC's fisheries research contribution to cumulative effects would be minor adverse under all the research alternatives.

Contribution of the No Research Alternative

Under the No Research Alternative, the NWFSC would not directly contribute to cumulative effects on fish in this region. Indirectly, however, the loss of information obtained through this research could have adverse impacts on fishery management decisions and analysis of long-term trends affecting target species such as salmon fisheries in the PSRA. The indirect contribution of the No Research Alternative to cumulative effects on any one species is difficult to ascertain, but it would likely have minor to moderate adverse impacts on long-term monitoring and management capabilities for many economically and ecologically important species.

5.4.3 Lower Columbia River Research Area

5.4.3.1 Endangered Species Act (ESA)-listed Species

External factors in the LCRRA

ESA-listed fish species that occur in the LCRRA include bull trout (Columbia River DPS), green sturgeon (southern DPS), Pacific eulachon (Southern DPS), and several ESUs of Chinook, chum, coho, and sockeye salmon, and steelhead (see Section 3 Section 3.3.1.1 and Table 3.2-1). The salmonids taken during NWFSC fisheries research (Table 4.2-11 and Table 4.2-12) are the focus of this section.

External factors in the LCRRA

External factors impacting ESA-listed salmonids in the LCRRA include habitat alterations related to dams (such as passage impediments and altered water flow), dredging and sediment transport, construction (e.g., pilings and dikes), invasive species, pinniped predation, water quality (e.g., from agricultural and urban run-off), and climate change (NMFS 2011d).

The Columbia River and its tributaries are a dominant aquatic system in the Pacific Northwest. Levees built along the river and dams across it have significantly altered hydrologic flow and reduced the abundance and quality of fish and wildlife habitat in the LCRRA. Aquatic habitats have been subject to human modifications (e.g., dredging, filling, armoring) to accommodate commercial and residential development, and few (if any) of these habitats are in pristine condition.

The Columbia River downstream of Bonneville Dam is highly altered by human disturbance. Urbanization extends up to the shoreline in many reaches that are near urban areas. There has been extensive removal of historic streamside forests and wetlands and riparian areas have been further degraded by the construction of dikes and levees and the placement of streambank armoring. For several decades, industrial, residential, and upstream agricultural sources have contributed to significant water quality degradation in the river. The river also receives high levels of disturbance in the form of heavy barge traffic.

Preliminary catch estimates of individual adult salmon within the Columbia River for the 2013 non-Indian commercial gillnet fisheries were 11,361 spring, 1,954 summer, and 117,740 fall Chinook. For treaty Indian fisheries, preliminary 2013 catch estimates of adult fish were 9,282 spring, 13,397 summer, and 234,351 fall Chinook. Recreational fishery preliminary catch estimates of adult salmon were 23,080 fall Chinook in the Buoy 10 fishery; 7,140 spring, 2,058 summer, and 32,710 fall Chinook in mainstem fisheries below Bonneville Dam; and 886 spring Chinook in mainstem fisheries above Bonneville Dam (NMFS 2007a). The proportion of these catches that are from ESA-listed stocks are not known.

The activities external to NWFSC fisheries research affecting ESA-listed species in the LCRRA will likely continue into the foreseeable future (see Table 5.1-1). The level of impact will depend on the application and efficacy of current and proposed mitigation measures and management schemes. The potential effects of climate variability are unpredictable, but are also likely to continue into and beyond the foreseeable future.

Contribution of the research alternatives

ESA-listed salmonids taken from 2008 to 2012 during NWFSC research in the LCRRA are listed in Table 4.2-9 and include Chinook, chum, and coho salmon, and steelhead trout. Many of these fish are sampled (with morphometric measurements taken and tags attached) and carefully released alive. No measureable population level effects are expected as a result of these takes, since they are small in comparison to ESU-specific population size estimates (Table 4.2-11 and Table 4.2-12).

Contribution of the No Research Alternative

Under the No Research Alternative, NWFSC would no longer conduct or fund research in the LCRRA, so would not directly contribute to cumulative effects on threatened and endangered fish species in this region. In the absence of research surveys, important scientific information would not be collected about the status of fish stocks used for fisheries and conservation management, including trends in abundance, recruitment rates, and the amount of fish being harvested relative to overfishing metrics. This lack of data would make it much more difficult for fisheries managers to effectively monitor the status of stocks, develop fishery regulations, and rebuild overfished stocks. NWFSC research in the LCRRA includes a study of contaminants and lower Columbia River salmon, and a study of juvenile salmon in the Columbia River estuary. NWFSC research also provides information on ecosystem characteristics important for monitoring potential effects from climate change and increases in ocean acidification, which could impact the population and distribution of many marine and anadromous species.

The indirect effects of the No Research Alternative could, therefore, result in adverse effects to fish through a lack of information essential for informed decision making and conservation of fish, their prey, and their habitats. The indirect contribution of the No Research Alternative to cumulative effects on any one species is difficult to ascertain, but would likely have minor to moderate adverse effects on long-term monitoring and management capabilities for ESA-listed species.

5.4.3.2 Target and Other Species

External factors in the LCRRA

Target species are those managed for tribal, recreational, and commercial fisheries and the subject of NWFSC fisheries research. These fisheries are the primary past, present, and reasonably foreseeable future activities that have or are likely to have the greatest effect on these species in the LCRRA external to NWFSC fisheries research. Natural population fluctuations and periodic short-term and longer term climate changes also affect population viability and stock sizes.

Target species in the LCRRA are managed through the PFMC and several fisheries management plans (FMPs) (Table 3.3.1). The analysis of effects in Chapter 4 focuses on those species most frequently caught (measured in numbers of fish rather than weights, which are generally not applicable to juvenile fish) in NWFSC research activities. The cumulative effects analysis takes a similar approach.

Commercial fisheries are the primary activity impacting target and other fish species in the LCRRA and will likely continue into the foreseeable future. The level of impact will depend on the application and efficacy of current and proposed mitigation measures and management schemes.

The activities affecting target and other species external to NWFSC fisheries research will likely continue into the foreseeable future (see Table 5.1-1).

Contribution of the research alternatives

All of the NWFSC research catch of target fish species in the LCRRA are smaller size classes than targeted by commercial fisheries. Differences in size classes taken limit direct take comparisons. The amount of fish captured in NWFSC research surveys is, however, considered minor for all species taken in the LCRRA due to the fact that almost all fish are juveniles and most are returned to the water alive after careful handling.

While mortality to target and other fish species is a direct effect of the NWFSC surveys, there are likely no measurable population changes occurring as a result of these research activities since they likely represent a small percentage of fish taken in commercial and recreational fisheries, which are just fractions of the total populations for these species.

When considered in conjunction with commercial and recreational fisheries and other external activities affecting target and other species in the PSRA, the NWFSC's fisheries research contribution to cumulative effects would be minor adverse under all the research.

Contribution of the No Research Alternative

Under the No Research Alternative, the NWFSC would no longer conduct or fund research in the LCRRA, so would not directly contribute to cumulative effects on target or other fish species in this region. In the absence of research surveys, important scientific information would not be collected about the status of fish stocks used for fisheries and conservation management, including trends in abundance, recruitment rates, and the amount of fish being harvested relative to overfishing metrics. This lack of data would make it much more difficult for fisheries managers to effectively monitor the status of stocks, develop fishery regulations, and rebuild overfished stocks. NWFSC research in the LCRRA includes a study of contaminants and lower Columbia River salmon, and a study of juvenile salmon in the Columbia River estuary. NWFSC research also provides information on ecosystem characteristics important for monitoring potential effects from climate change and increases in ocean acidification, which could impact the population and distribution of many marine and anadromous species. The indirect effects of the No Research Alternative could, therefore, result in adverse effects to fish through a lack of information essential for informed decision making and conservation of fish, their prey, and their habitats. The indirect contribution of the No Research Alternative to cumulative effects on any one species is difficult to ascertain, but would likely have minor to moderate adverse effects on long-term monitoring and management capabilities for target and other species.

5.5 CUMULATIVE EFFECTS ON MARINE MAMMALS

5.5.1 California Current Research Area

Activities external to NWFSC fisheries research that may potentially affect marine mammals in the CCRA include commercial and recreational fisheries, vessel traffic, ocean discharges, dredging, geophysical activities and oil extraction, other scientific research, military operations, conservation measures, and climate change. These activities and potential effects are summarized in Table 5.1-1 and include:

- Disturbance/behavioral changes or physical effects from anthropogenic noise (e.g., marine vessels of all types, military readiness operations, navigational equipment, construction, seismic surveys)
- Injury or mortality due to vessel collisions, entanglement in fishing gear, and contamination of the marine environment
- Changes in food availability due to prey removal, ecosystem change, or habitat degradation

5.5.1.1 ESA-Listed Species

External Factors in the CCRA

The endangered marine mammal species in the CCRA include the Southern Resident killer whale (SRKW) Distinct Population Segment (DPS), sperm whales, humpback, blue, fin, sei whales, and, periodically, individuals from the western North Pacific stock of gray whales. Threatened species include Guadalupe fur seals and the southern subspecies of sea otters. Commercial whaling was the single greatest historical source of mortality for the endangered whale species (except killer whales), as was commercial sealing for Guadalupe fur seals during the 19th century (Carretta et al. 2011 and citations therein, Perry et al. 1999). Commercial harvests of sperm whales ended worldwide in 1986 (NMFS 2006). Humpback whales and blue whales were protected in 1966 (NMFS 1998, Perry et al. 1999). The International Whaling Commission (IWC) banned hunting of fin whales throughout the North Pacific in 1976 (Perry et al. 1999). Hunting of sei whales in the eastern North Pacific ended after 1971 and after 1975 in the western North Pacific (Perry et al. 1999).

Live capture of killer whales in Washington and British Columbia for use in aquaria was a major historical source of population decline for SRKWs between 1962 and 1977. Seventy percent (47 or 48 animals) of the whales retained or killed were Southern Residents (NMFS 2008a, and citations therein).

Commercial harvests of sea otters for their pelts during the 18th and 19th centuries nearly extirpated the species throughout its range. Southern sea otter populations gradually expanded along the central California coast after being protected under the International Fur Seal Treaty in 1911 (Carretta et al. 2011, and citations therein).

More recent past, present, and reasonably foreseeable future conservation concerns and threats to recovery are outlined in the respective recovery plans for the ESA-listed species for which plans exist. Those for blue whales (NMFS 1998), humpback whales (NMFS 1991), sperm whales (NMFS 2006), fin whales (NMFS 2010a), sei whales (NMFS 2011a), SRKWs (NMFS 2008a), and southern sea otters (U.S. Fish and Wildlife Service [USFWS] 2003) were finalized or recently updated. Noted conservation concerns and threats include vessel collisions, entanglement in fishing gear, anthropogenic noise, vessel/human disturbance, pollutants (including contaminants and oil spills) and pathogens, disease, habitat degradation, competition with fisheries for prey, and climate change.

Vessel collisions are considered threats for several endangered large whales, particularly blue, humpback, and fin whales. The contribution of ship strikes to the annual average anthropogenic sources of mortality is noted in Section 3.2.2 under the respective species descriptions. The Pacific coast of the U.S. includes numerous shipping lanes, active ports and vessel traffic. The major container ports are Seattle, Tacoma, Portland, Oakland, Long Beach and Los Angeles. The Santa Barbara Channel, through which most Long Beach and Los Angeles-bound vessels transit, contains some of the highest densities of commercial maritime traffic in the world. An average of 6,500 large (over 300 gross tons) vessels annually pass through the Channel, most at speeds greater than 14 knots (kts) (Channel Islands National Marine Sanctuary [CINMS] 2006 cited in Abramson et al 2009). In addition, there are several large Naval bases (e.g., Naval Base San Diego, the largest on the West Coast and home to the Pacific Fleet) and U.S. Coast Guard (USCG) Stations in Washington and California.

Fin whales had the highest incidence of confirmed ship strike mortality (five whales), followed by blue whales (two) and humpback whales (one) along the Washington coast between 1980 and 2006. Three of the fin whales and one of the blue whales were discovered draped over the bows of container ships. Possible additional ship strike mortalities include two fin whales, one sperm whale, and one sei whale (Douglas et al. 2008).

An average of three large whales per year was found dead along the California coast between 2000 and 2011 with injuries caused by ship strike (Kennedy 2012). Between September and November 2007, five blue whale deaths in the Southern California Bight near the Northern Channel Islands were attributed to ship strikes. NMFS designated these deaths an Unusual Mortality Event (UME), which the MMPA defines as "a stranding that is unexpected; involves a significant die-off of any marine mammal population; and demands immediate response" (CINMS 2008). In 2010, two blue whales, one humpback, and two fin whales were found dead in and around Monterey Bay, Gulf of the Farallones, and Cordell Bank NMS and one blue whale was found dead on San Miguel Island within CINMS (Kennedy 2012).

In response to the UME in 2007, NOAA developed numerous mitigation and monitoring measures to address ship strikes, especially in the Santa Barbara Channel. This includes a seasonal Whale Advisory Zone. When five or more blue, humpback, and/or fin whales are sighted in the Whale Advisory Zone during monitoring of shipping lanes, NOAA coordinates with USCG and National Weather Service to broadcast a notice to mariners advising ships over 300 gross tons to watch for large whales and to maintain speeds of 10 kts or less (<http://channelislands.noaa.gov/management/resource/regulations.html>). Based on Automatic Identification System station data on ships transiting within and outside the Santa Barbara Channel during 2007-2009, CINMS staff found that most ships have not slowed to 10 kts (Kennedy 2012).

The USCG completed a Port Access Route Study in 2011 for San Francisco Bay. A formal proposal was submitted to the IMO to extend the northern (17 nm), western (3 nm), and southern (8.5 nm) shipping lanes and to narrow the northern and western lanes to three nautical miles wide each. The northern and western shipping lanes were also shifted slightly (33 CFR 167). These changes will keep vessels on a more predictable path and avoid the Area of Special Biological Significance at Point Reyes and an important feeding area for whales at Cordell Bank National Marine Sanctuary (NOAA 2012). Collaborative efforts of a number of groups, agencies, and the U.S. Coast Guard led the International Maritime Organization (IMO) to amend shipping lane approaches to the Los Angeles, Long Beach, and San Francisco Bay ports to reduce the co-occurrence of whales and ships in the San Francisco Bay area and in the Santa Barbara Channel, effective June 2013 (NOAA Sanctuaries 2013).

Disturbance by vessels is a possible contributing factor in the recent decline in the population of SRKW (NMFS 2008a). In order to protect killer whales from interference and noise associated with vessels, in 2011, NMFS established regulations prohibiting vessels from approaching killer whales within 200 yards (182.9 meters [m]) and from parking in the path of whales when in inland waters of Washington State (76

FR 20870). This should help reduce the number and severity of vessel incidents and promote population growth and recovery (NMFS 2010b).

Entanglement in fishing gear is another concern for several ESA-listed species. Overall, the level of take for ESA-listed marine mammals in the CCRA is relatively low. There are no fisheries mortalities or serious injuries documented for blue or sei whales. The estimated mean annual take of fin whales in unidentified fisheries was ≥ 0.6 for 2007-2011, based on at-sea sightings. The mean annual take of sperm whales by the California/Oregon thresher shark/swordfish drift gillnet fishery was 3.2 and was ≥ 0.6 in unknown fisheries for 2006-2010. The mean annual take of humpback whales in pot or trap fisheries and unknown fisheries was ≥ 4.4 for the years 2007-2011. Mean annual fishery takes of sperm whales and of humpback whales exceed ten percent of their respective potential biological removal (PBR) levels, so are not approaching zero mortality and serious injury (M&SI) rates (Carretta et al. 2014). Drift and set gillnet fisheries may cause incidental mortality of Guadalupe fur seals, but there are no reports of mortality or injuries in the U.S. and information is not available for Mexico. Information on takes of southern sea otters in commercial fisheries is limited, although drift and set gillnet fisheries, purse seine fisheries, pot fisheries, and hook-and-line fisheries have the potential to kill or injure southern sea otters (Carretta et al. 2014).

The Pacific Offshore Cetacean Take Reduction Plan (POCTRP) was finalized in 1997 to reduce the level of M&SI of several marine mammal stocks, including sperm and humpback whales, in the California/Oregon drift gillnet fishery for thresher shark and swordfish (62 FR 51805). Data from 2008-2009 indicated that the POCTRP achieved the MMPA short term goal of reducing serious injuries and mortalities of all strategic stocks to below PBR and the long term goal of reducing serious injuries and mortalities of all marine mammals (except long-beaked common dolphins) to insignificant levels (POCTRT 2009). At the time of the February 2014 meeting of the Pacific Offshore Cetacean Take Reduction Team, sperm whales were the only species covered under the POCTRP with a five-year (2007-2011) annual average mortality and serious injury rate (3.2) that exceeded PBR (1.5) (POCTRT 2014). These data included one mortality and one serious injury observed in the California thresher shark/swordfish fishery in 2010, the only year with observed takes (Carretta et al. 2015). There were, however, no TRP species taken in the fishery in 2012 or 2013 (POCTRT 2014). NMFS issued a temporary emergency rule, effective September 2013 through January 2014 (78 FR 54548, September 4, 2012). The rule required immediate closure of the California thresher shark/swordfish drift gillnet (DGN) fishery if one sperm whale was observed killed or seriously injured and all DGN vessels were required to carry NMFS-trained observers in the 100 percent observer coverage area. Sperm whale abundance estimates, PBR calculations, and mean annual takes in this fishery have since been revised. Total annual takes (≥ 1.7 , 1.3 of which is from the thresher shark/swordfish drift gillnet fishery and 0.4 in unknown fisheries) is now less than the calculated PBR (2.7) for the CA/OR/WA stock of sperm whales, although it still exceeds ten percent of PBR (Carretta et al. 2015).

The potential effects of commercial fisheries on prey availability are not clear. Direct competition with fisheries for prey is unlikely for blue, fin, and sei whales whose diet consists of 80-100% large zooplankton, primarily krill (Barlow et al. 2008). Humpbacks consume roughly 50% large zooplankton, along with small pelagic and miscellaneous fish. Sperm whales consume about 60% large squid, and a mix of various fish, small squid, and benthic invertebrates. Krill is not commercially harvested, nor are most of the other prey items (Barlow et al. 2008).

Recovery plans for SRKWs identified reduced prey availability as a risk to the population. A recent finding that glucocorticoid levels (an indicator of stress) in SRKW correlated with an index of Chinook salmon availability suggests that prey availability has a stronger physiological impact on SRKWs than does vessel traffic (Ayres et al. 2012). Chinook salmon is overwhelmingly the most frequently consumed prey, of which 80-90% is from the Fraser River (Hanson et al 2010). The SRKW population may consume 12–23% of available Fraser River Chinook in the region from May–September, which might

exceed takes from all fisheries in the region combined. As both species have at-risk conservation status and transboundary (Canada–U.S.) ranges, there could be competition between conservation objectives for killer whales and Chinook salmon (Williams et al. 2011).

Military operations along the West Coast and offshore waters are also potential sources of behavioral and habitat disturbance, injury, and mortality. Operations occur throughout several range complexes and testing ranges, including the Southern California (SOCAL) Offshore Complex along the California coast from Santa Barbara to Baja California and the Northwest Testing Range Complex (NWTRC) from northern California to Cape Flattery, WA and Puget Sound (DON 2013, NMFS 2014f). Sonar, active acoustic sources, airguns, weapons firing, explosives, and vessel and aircraft noise could result in Level A or Level B harassment of some marine mammals, and vessel collisions and explosives could result in injury or mortality. The Navy coordinated with NMFS, through consultation and permitting processes, on mitigation measures (DoN 2013, NMFS 2014f).

Climate change impacts on ESA-listed species are possible through changes in habitat and food availability. Migration, feeding, and breeding locations influenced by ocean currents and water temperature could be impacted, which could, ultimately, affect productivity of ESA-listed species (NMFS 2010b, NMFS 2011a).

With the exception of the historical sources of population decline, all of the aforementioned effects are likely to continue into the foreseeable future (see Table 5.1-1). The level of impact will depend on the application and efficacy of current and proposed mitigation measures. The potential effects of climate change are unpredictable, but are also likely to continue into and beyond the foreseeable future.

Contribution of the Research Alternatives

Direct and indirect effects of the research alternatives on ESA-listed marine mammals are discussed in sections 4.2.4, 4.3.4, and 4.4.4. The three research alternatives considered in this DPEA include similar scopes of research. The primary differences lie in the number and types of associated mitigation measures for protected species. Although ESA-listed marine mammals continue to be affected by numerous factors external to NWFSC fisheries research in the CCRA, and the resulting cumulative effects, contribution to these effects from NWFSC fisheries research activities is comparatively small.

There have been no reported vessel collisions or entanglements of current ESA-listed marine mammals involving NWFSC vessels or gear, and the volume of ship traffic generated by NWFSC fisheries research is miniscule compared to the number of other vessels transiting the area. Given the relatively slow speeds of research vessels, mitigation measures, and the small number of research cruises, the likelihood of fisheries research vessels causing serious injury or mortality to ESA-listed species due to ship strikes is considered possible, but the potential risk is minor.

The potential effects from use of active acoustic devices for research activities would have rare or infrequent and temporary behavioral avoidance effects on ESA-listed marine mammals. Relative to the volume of other ship traffic and other anthropogenic sources of acoustic disturbance, the contribution of noise from NWFSC research would be minor.

There have been no known adverse interactions or takes of current ESA-listed marine mammals during NWFSC fisheries research and Level A takes of ESA-listed species are not anticipated (the eastern stock of Steller sea lions, from which there are historical takes, was delisted in 2013 and is now included in Other Pinnipeds below). Incidental take in external commercial fisheries and the volume of ship strikes from external sources exceeds any known or potential takes by NWFSC fisheries research, none of which are ESA-listed species. Prey removal during fisheries research is very small and likely inconsequential to prey availability for any marine mammal species, particularly the planktivorous, or largely plantivorous, species. When considered in conjunction with commercial and recreational fisheries and aggregated with other past, present, and reasonably foreseeable future activities affecting ESA-listed marine mammals in

the CCRA, the contribution of NWFSC fisheries research activities to cumulative effects on ESA-listed marine mammals would be minor adverse under all three research alternatives.

Contribution of the No Research Alternative

Under the No Research Alternative, NWFSC would no longer conduct or fund the fisheries and ecosystem research considered in the scope of this DPEA, so would not directly contribute to cumulative effects on ESA-listed marine mammals in the CCRA. Indirectly, however, the loss of information obtained through this research, either directly or indirectly, on marine mammal feeding ecology, oceanographic components of their habitat, and status of prey stocks could have minor adverse impacts on management decisions and analysis of ecological trends affecting marine mammal habitat. The indirect contribution of the No Research Alternative to cumulative effects is difficult to ascertain for individual species given the availability of other sources of marine mammal information, but could impact monitoring and management capabilities for ESA-listed marine mammals in the region. When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting ESA-listed marine mammals in the NWFSC research areas, the contribution of the No Research Alternative to cumulative effects on ESA-listed marine mammals would be minor adverse.

5.5.1.2 Other Cetaceans

External Factors in the CCRA

The cetacean species included in this section are not listed as threatened or endangered. They are all subject to similar types of effects from external activities as described above for ESA-listed species. With the exception of minke whales and gray whales, the non-ESA listed cetaceans in the CCRA are odontocetes. Habitats are wide ranging, as are preferred prey items. Interactions with commercial fisheries are likely to have the greatest effect on most of these species and are generally well-documented. The gray whale is the only species included in this section that was subjected to large-scale commercial whaling, as well as historical and current hunting for subsistence purposes. The IWC banned commercial whaling of gray whales in the late-1940s and, after decades of recovery and population growth, the Eastern North Pacific stock was removed from the List of Threatened and Endangered Wildlife in 1994. The U.S. and Russia share a combined harvest quota, with an average annual harvest allocation of 120 whales by the Russian Chukotka people and four whales by the Makah Indian Tribe. The average annual take by the Russian hunt was 123 whales from 2007 to 2011 (Carretta et al. 2014).

Fisheries in which these species have been subject to mortality or serious injury include set gillnet fisheries (harbor porpoise), Washington/Oregon/California domestic groundfish trawl (Dall's porpoise), Puget Sound salmon drift gillnet (Dall's porpoise), California/Oregon thresher shark/swordfish drift gillnet fishery (Pacific white-sided dolphins, Risso's dolphins, short- and long-beaked common dolphins, and northern right whale dolphin), West Coast limited entry bottom trawl fishery (Pacific white-sided dolphins), California squid purse seine (short-beaked common dolphins), California small mesh drift gillnet fishery for white seabass, yellowtail, barracuda, and tuna (long-beaked common dolphins), and unknown fisheries (Carretta et al. 2014). The reported number of takes is less than 10 percent of the respective PBR levels for each of these species, so population-level effects from commercial fishery takes are minor. There were no reported takes of striped dolphins (Carretta et al. 2014).

Mitigation measures effectively reduced Level A takes for harbor porpoise in central California coastal gillnet fisheries and for several species in the California/Oregon thresher shark/swordfish drift gillnet fishery. A 2002 ban on gillnets inshore of the 60 fathom (110 m) isobath from Point Arguello to Point Reyes was thought to reduce potential harbor porpoise mortality to near zero for the Morro Bay, Monterey Bay, and San Francisco-Russian River stocks (Carretta et al. 2014). Low levels of take of harbor porpoise in unknown fisheries occur north of the closure area from northern California to the

Washington coast (Carretta et al. 2014). Implementation of the POCTRP in 1997 (62 FR 51805) resulted in considerable decreases in overall cetacean entanglement rates in the drift gillnet fishery. Data from 2008-2009, indicated that the POCTRP achieved the MMPA short term goal of reducing serious injuries and mortalities of all strategic stocks to below PBR and the long term goal of reducing serious injuries and mortalities of all marine mammals (except long-beaked common dolphins) to insignificant levels (POCTRT 2009).

In addition, research conducted by the Southwest Fisheries Science Center (SWFSC) occurs in some of the same areas affected by NWFSC research, and is therefore considered in the set of external factors that contribute to cumulative effects in the CCRA. The SWFSC has conducted its own NEPA and MMPA compliance process and requested authorization for incidental take many of the same marine mammal stocks as the NWFSC (see Proposed Rule for the SWFSC, 80 FR 8166, 13 February 2015). Table 5.5-1 indicates the requested takes by both the SWFSC and NWFSC in the California Current area for all shared species. Note that these are conservative estimates of takes and the actual level of taking by both centers is likely to be much less than these requested takes.

Military operations along the West Coast and offshore waters are also potential sources of behavioral and habitat disturbance, injury, and mortality. Operations occur throughout several range complexes and testing ranges, including the Northwest Testing Range Complex (NWTRC) from northern California to Cape Flattery, WA and Puget Sound (NMFS 2014f). Sonar, active acoustic sources, airguns, weapons firing, explosives, and vessel and aircraft noise could result in Level A or Level B harassment of some marine mammals, and vessel collisions and explosives could result in injury or mortality. The Navy coordinated with NMFS, through consultation and permitting processes, on mitigation measures (NMFS 2014f).

Prey consumed by cetaceans considered here includes some commercially valuable species, such as herring and anchovies that are preyed upon by harbor porpoise, plus an array of non-commercially important mesopelagic fish, small pelagic fish, squid, and miscellaneous fish (Barlow et al. 2008). It is unlikely that commercial fisheries affect the availability of prey for non ESA-listed cetaceans.

Climate change impacts are difficult to predict, but will likely affect non ESA-listed cetaceans through changes in habitat and food availability.

The activities external to NWFSC fisheries research affecting cetaceans are likely to continue into the foreseeable future (Table 5.1-1). The level of impact will depend on the application and efficacy of current and proposed mitigation measures. The potential effects of climate change are unpredictable, but are also likely to continue into and beyond the foreseeable future.

Table 5.5-1 Requested Potential Takes of Non-ESA-Listed Marine Mammals by the SWFSC and the NWFSC in the CCRA

This table combines potential Mortality and Serious Injury (M&SI) and Level A harassment takes requested by the NWFSC and the SWFSC for species in the CCRA where the respective Science Center fisheries research overlaps.

Takes requested include trawl and longline gear. Potential Biological Removal (PBR) values are from the most recent stock assessment reports (Allen and Angliss 2014, Carretta et al. 2014, Carretta et al. 2015). Since PBR is an annual measure of mortality, potential takes requested for the five-year LOA application periods are shown along with annual average take estimates for comparison with PBR.

Species	PBR (Animals per Year)	Potential M&SI and Level A Take Average per Year (Total for Five-year Period)		
		NWFSC	SWFSC	Total
Harbor porpoise (several stocks)	Morro Bay: 21; Monterey Bay: 25; SF-Russian River: 66; N.CA/S.OR: 475; N.OR/WA Coast: 151; WA Inland Waters: 63	1 (5)	1 (5)	2 (10)
Dall's porpoise	257	0.6 (3)	1 (5)	1.6 (8)
Pacific white-sided dolphin	171	6.2 (31)	7 (35)	13.2 (66)
Risso's dolphin	39	1.6 (8)	2.4 (12)	4 (20)
Bottlenose dolphin (all stocks)	CA Coastal: 2.4; CA/OR/WA Offshore: 5.5	0.4 (2)	0.8 (4) coastal 1.8 (9) offshore	1.2 (6) coastal 2.2 (11) offshore
Striped dolphin	82	1.4 (7)	2.4 (12)	3.8 (19)
Short-beaked common dolphin	3,440	0.6 (3)	2.4 (12)	3 (15)
Long-beaked common dolphin	610	0.4 (2)	2.4 (12)	2.8 (14)
Northern right-whale dolphin	48	1.4 (7)	2 (10)	3.4 (17)
Short-finned pilot whale	4.6	0.2 (1)	0.2 (1)	0.4 (2)
Pygmy sperm whale and Dwarf sperm whale	Pygmy: 2.7 Dwarf: undetermined	0.2 (1)	0.2 (1)	0.4 (2)
Undetermined porpoise or dolphin species		0.2 (1)	0.2 (1)	0.4 (2)
California sea lion	9,200	2 (10)	5 (25)	7 (35)

Species	PBR (Animals per Year)	Potential M&SI and Level A Take Average per Year (Total for Five-year Period)		
		NWFSC	SWFSC	Total
Steller sea lion (Eastern DPS)	1,552	1.8 (9)	2 (10)	3.8 (19)
Northern fur seal (two stocks)	California: 403; Eastern Pacific: 11,638	1 (5)	1 (5)	2 (10)
Harbor seal¹	1,641	2.6 (13)	1.8 (9)	4.4 (22)
Undetermined pinniped species		0.2 (1)	0.4 (2)	0.6 (3)

1. Population estimate and PBR values are for the California stock of harbor seals only. There are no recent population estimates or PBR determinations for the Oregon/Washington Coast, Washington Northern Inland Waters, Southern Puget Sound, or Hood Canal stocks.

2. The SWFSC also requested takes of short-finned pilot whale, *Kogia* spp. (pygmy and dwarf sperm whale), and northern elephant seal. The NWFSC does not anticipate taking these species in research gear.

Contribution of the Research Alternatives

Direct and indirect effects of the research alternatives on non-ESA-listed cetaceans are discussed in sections 4.2.4, 4.3.4, and 4.4.4. The three research alternatives considered in this DPEA include similar scopes of research. The primary differences lie in the number and types of associated mitigation measures for protected species. The contribution of NWFSC fisheries research activities to cumulative effects on non-ESA-listed species is likely to be small.

There have been no reported vessel collisions with cetaceans involving NWFSC vessels and the volume of ship traffic generated by NWFSC fisheries research is miniscule compared to the number of other vessels transiting the area. Given the relatively slow speeds of research vessels, mitigation measures, and the small number of research cruises, the likelihood of fisheries research vessels causing serious injury or mortality to non-ESA-listed species due to ship strikes is considered possible, but the potential risk is minor.

Annual incidental take levels in external commercial fisheries exceed any known Level A takes by NWFSC fisheries research (Table 4.2-14). The estimated average annual take by NWFSC in the next five years is well below 10 percent of PBR for almost all species for which takes are requested except for two stocks of bottlenose dolphin, which, if all takes were only from one stock, would have takes between 10 percent and 50 percent of PBR (Table 4.2-16). The combined estimated takes from the NWFSC and the SWFSC basically follow this pattern in relation to PBR except for some stocks with very small population estimates (Table 5.5-1). Although the Centers have included these small stocks in their take requests to ensure accounting for maximum precautionary level of potential take, due to their small numbers and the limited research efforts in the restricted geographic ranges of those small stocks, it is very unlikely that future incidental takes, if they occur, would be concentrated on small stocks where population-level effects might result. According to the impact criteria described in Table 4.1-1, the level of mortality of the species considered here, if they occurred, would be considered minor in magnitude.

The potential effects from use of active acoustic devices for research activities would likely involve infrequent and temporary behavioral disturbance and avoidance effects, particularly for the mid- and

high-frequency hearing odontocetes. Relative to the volume of other ship traffic and anthropogenic sources of acoustic disturbance, the contribution of noise from NWFSC research would be minor.

Although there is some overlap in prey of non-ESA-listed cetaceans and the species collected during NWFSC research surveys, the total amount sampled is minimal compared to overall biomass and commercial fisheries removals. Prey removal during fisheries research is very small and likely inconsequential to prey availability for any marine mammal species. The contribution of research catches to the effects on cetaceans through competition for prey is therefore considered minor adverse.

When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting non-ESA-listed cetaceans in the CCRA, the contribution of NWFSC-affiliated fisheries research to cumulative effects on cetaceans would be primarily through infrequent gear interactions and would be minor adverse under all three research alternatives.

Contribution of the No Research Alternative

Under the No Research Alternative, NWFSC would no longer conduct or fund the fisheries and ecosystem research considered in the scope of this DPEA, so would not directly contribute to cumulative effects on non-ESA-listed cetaceans in the CCRA. Indirectly, however, the loss of information obtained through this research, either directly or indirectly, on marine mammal feeding ecology, oceanographic components of their habitat, and status of prey stocks could have minor adverse impacts on management decisions and monitoring of ecological trends. The indirect contribution of the No Research Alternative to cumulative effects is difficult to ascertain for individual species, but could impact monitoring and management capabilities for cetaceans in the region. When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting non-ESA-listed cetaceans in the CCRA, the contribution of the No Research Alternative to cumulative effects would be minor adverse.

5.5.1.3 Other Pinnipeds

External Factors in the CCRA

Five species of non-ESA-listed pinnipeds commonly occur in the CCRA, including California sea lions, Steller sea lions (delisted in 2013), northern fur seals, harbor seals (several stocks), and northern elephant seals. These species are all subject to similar types of effects from external activities as described above for other species. Interactions with commercial fisheries likely have the greatest effect on most of these species and are also generally well-documented.

Fisheries in which California sea lions have been subject to mortality or serious injury in the CCRA include the CA/OR thresher shark/swordfish large mesh drift gillnet fishery, CA halibut and white seabass set gillnet fishery, CA small-mesh drift gillnet fishery for white seabass, yellowtail, barracuda, and tuna; CA anchovy, mackerel, and tuna purse seine fishery; WA/OR/CA domestic groundfish trawl fishery; unknown entangling net fisheries; and unknown pot or trap fisheries. The minimum total annual take (2005-2009) was ≥ 337 animals, but well below ten percent of the PBR of 9,200 (Carretta et al. 2014).

The U.S. West Coast commercial fisheries in which Steller sea lions (eastern stock) were taken between 2005 and 2009 include the WA/OR/CA groundfish and halibut trawl fisheries. The mean annual mortality, based on observer data, was 5.71 sea lions, well below ten percent of the PBR of 1,552 (Allen and Angliss 2014).

Of the stocks of harbor seals in the CCRA, the California stock experiences the highest level of incidental take (an average of 18 per year, 2004-2009), primarily in the CA halibut and white seabass fishery and the WA/OR/CA groundfish trawl fishery. This level of annual mortality is less than ten percent of the calculated PBR (1,641), so is considered insignificant and approaching zero M&SI rate. There is currently

no PBR estimate for the Oregon/Washington coastal stock, but levels of annual mortality are relatively low (>8.2 , 2007-2011), and primarily occur in the Northern Washington marine set gillnet fishery; and the West Coast groundfish trawl, nearshore fixed gear, and non-nearshore fixed gear fisheries (Carretta et al. 2014).

While it is possible for northern fur seals from the Eastern Pacific stock to be taken during the winter/spring along the continental U.S. West Coast, for the purposes of the stock assessment reports, NMFS considers any northern fur seals taken by commercial fisheries off California, Oregon and Washington to be from the California stock. Between 2007 and 2011, there were no reported deaths in any observed fishery along the West Coast of the continental U.S. Two fishery-related deaths were reported based on stranding data during this period, for a mean annual take of 0.4 (Carretta et al. 2014).

Pinnipeds in the CCRA have a diverse diet that includes Pacific whiting, market squid, northern anchovy, Pacific herring, and Pacific sardine. All support commercially valuable fisheries which could potentially affect prey availability (Baraff and Loughlin 2000). Pacific whiting is widely available as prey, commonly consumed, and is one of the most commercially valuable and abundant groundfish resources of the California Current. There are, however, no indications of resource competition along the Oregon and Washington outer coasts and, since the fishery is essentially closed south of 42°N latitude, impacts on pinnipeds in southern and central California are unlikely. Pinniped predation on herring and the commercial fishery coincide during the fall–winter spawning season, but there do not appear to be any conflicts over prey availability (Baraff and Loughlin 2000).

Military operations are also potential sources of behavioral and habitat disturbance, injury, and mortality. The Northwest Testing Range Complex (NWTRC) includes waters from northern California to Cape Flattery, WA and Puget Sound (NMFS 2014f). Sonar, active acoustic sources, airguns, weapons firing, explosives, and vessel and aircraft noise could result in Level A or Level B harassment of some pinnipeds, and vessel collisions and explosives could result in injury or mortality. The Navy coordinated with NMFS, through consultation and permitting processes, on mitigation measures (NMFS 2012b, NMFS 2014f).

Climate change impacts are difficult to predict, but may affect non ESA-listed pinnipeds through changes in habitat and food availability.

The activities external to NWFSC fisheries research affecting pinnipeds are likely to continue into the foreseeable future (see Table 5.1-1). The level of impact will depend on the application and efficacy of current and proposed mitigation measures. The potential effects of climate change are unpredictable, but are also likely to continue into and beyond the foreseeable future.

Contribution of the Research Alternatives

Direct and indirect effects of the NWFSC research alternatives on pinnipeds are discussed in sections 4.2.4, 4.3.4, and 4.4.4. The three research alternatives considered in this DPEA include similar scopes of research. The primary differences lie in the number and types of associated mitigation measures for protected species. The contribution of NWFSC fisheries research activities to cumulative effects on pinnipeds is likely to be small.

There have been no reported vessel collisions with pinnipeds involving NWFSC vessels and the volume of ship traffic generated by NWFSC fisheries research is a very small fraction of the total number of other vessels transiting the area. Given the relatively slow speeds of research vessels, mitigation measures, and the low number of research cruises, the likelihood of fisheries research vessels causing serious injury or mortality to non ESA-listed pinnipeds due to ship strikes is possible, but the potential risk is minor.

The potential effects from use of active acoustic devices for research activities could infrequently and temporarily elicit behavioral avoidance effects on pinnipeds in the CCRA. Relative to the volume of other

ship traffic and other anthropogenic sources of acoustic disturbance, the contribution of noise from NWFSC research would be minor.

Incidental take in external commercial fisheries exceeds any known or potential Level A takes by NWFSC fisheries research (Tables 4.2-13 and 4.2-15). There were 15 takes of four species (California sea lion (4), Steller sea lion (8), northern fur seal (1) and harbor seal (2)) in the CCRA between 1999 and 2014. Since 2009, there have only been two takes of California sea lions and one harbor seal in the CCRA. The estimated average annual take by NWFSC in the next five years is less than 0.1 percent of PBR for all but northern fur seal, for which it is 0.25% of PBR. The contribution of NWFSC fisheries research takes to cumulative effects on these species, if they occur, would be considered minor adverse.

Although there is some overlap in prey of pinnipeds in the CCRA and the species collected during NWFSC research surveys, the total amount sampled is minimal compared to overall biomass and commercial fisheries removals. The contribution of research catches to the effects on marine mammals through competition for prey is therefore considered minor adverse for cetaceans in the CCRA.

When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting pinnipeds in the CCRA, the contribution of the NWFSC fisheries research in the CCRA to cumulative effects on these species through disturbance, direct takes, and prey removal would be minor adverse under all three research alternatives.

Contribution of the No Research Alternative

Under the No Research Alternative, NWFSC would no longer conduct or fund the fisheries and ecosystem research considered in the scope of this DPEA, so would not directly contribute to cumulative effects on non-ESA-listed pinnipeds in the CCRA. Indirectly, however, the loss of information obtained through this research on feeding ecology, oceanographic components of their habitat, and status of prey stocks could have minor adverse impacts on management decisions regarding pinnipeds and monitoring of ecological trends. When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting pinnipeds in the CCRA, the contribution of the No Research Alternative to cumulative effects on pinnipeds would be minor adverse.

5.5.1.4 Sea Otters

External Factors in the CCRA

Sea otters along the Washington coast were extirpated by an intensive harvest for their pelts beginning in the 18th century. Sea otters were absent from the state from 1911 until 1969, when 59 sea otters were reintroduced to the Washington coast from Amchitka Island, Alaska (Lance et al. 2004).

More recent past, present, and reasonably foreseeable future conservation concerns and threats include oil spills, contaminants, disease, marine biotoxins, entanglement and entrapment, habitat loss, and low genetic diversity (Lance et al. 2004). The relatively small population size and range of northern sea otters in Washington may leave them particularly vulnerable to habitat destruction or loss and, currently, oil spills and disease are of primary concern (Lance et al. 2004).

Fisheries interactions also occur, particularly via drowning in gillnets. An estimated minimum of two mortalities a year occur in the Makah Northern Washington Marine Set Gillnet Fishery when there is fishing effort. Data are lacking for other fisheries within the sea otter range in Washington, including treaty and non-treaty gillnet fisheries in the Strait of Juan de Fuca, Puget Sound, and Grays Harbor (Carretta et al. 2014).

Sea otters in Washington State primarily consume sea urchins, clams, crabs, and mussels. Localized fisheries management issues are possible given that several shellfish species are also important to commercial, recreational, and tribal fisheries in Washington (Lance et al. 2004).

The activities external to NWFSC fisheries research that affect northern sea otters are likely to continue into the foreseeable future (see Table 5.1-1). The level of impact will depend on the application and efficacy of current and proposed mitigation measures.

Contribution of the Research Alternatives

Although NWFSC conducts research along the outer Washington coast, the NWFSC does not anticipate any future Level B or Level A takes of sea otters from this population based on a lack of historical takes and very little spatial overlap between sea otter habitat and NWFSC research activities. The risk of future disturbance, injury, or competition for prey under any of the research alternatives is considered minor. When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting this stock of sea otters in the CCRA, the contribution of the three research alternatives to cumulative effects on this species through disturbance, direct takes, and prey removal would be minor adverse.

Contribution of the No Research Alternative

Under the No Research Alternative, NWFSC would not directly contribute to cumulative effects on sea otters in the CCRA. Indirectly, however, the loss of information obtained through NWFSC fisheries and ecosystem research on the oceanographic components of sea otter marine habitat and status of prey stocks could have adverse impacts on management decisions concerning sea otters. The indirect contribution of the No Research Alternative to cumulative effects on sea otters is difficult to ascertain but, when considered in conjunction with other past, present, and reasonably foreseeable future activities affecting sea otters in the CCRA, the contribution of the No Research Alternative to cumulative effects on this species would be minor adverse.

5.5.2 Puget Sound Research Area

Activities external to NWFSC research that may potentially affect marine mammals in the PSRA include commercial fisheries, vessel traffic, ocean discharges and runoff, dredging, other scientific research, military operations, conservation measures, and climate change. These activities and potential effects are summarized in Table 5.1.1 and include:

- Disturbance/behavioral changes or physical effects from anthropogenic noise
- Injury or mortality due to vessel collisions, entanglement in fishing gear, and contamination of the marine environment
- Changes in food availability due to prey removal, ecosystem change, or habitat degradation

5.5.2.1 ESA-listed Species

External Factors in the PSRA

The endangered marine mammals that occur in the PSRA include the Southern Resident Distinct Population Segment (DPS) of killer whales (SRKW) and, on a rare occasion, humpback whales. The focus in this section is on SRKW. Live capture of killer whales in Washington and British Columbia for use in aquaria was a major historical source of population decline for SRKWs between 1962 and 1977. Seventy percent (47 or 48 animals) of the whales retained or killed were Southern Residents (NMFS 2008b, and citations therein).

Vessel disturbance and prey availability are the primary concerns for SRKW identified in the recovery plan (NMFS 2008a). In 2011, NMFS established regulations prohibiting vessels from approaching killer whales within 200 yards (182.9 meters [m]) and from parking in the path of whales when in inland waters of Washington State in order to protect killer whales from interference and noise associated with vessels (76 FR 20870). Reduced prey availability is also considered a risk factor for the population and may have a stronger physiological impact on SRKW than does vessel traffic, as indicated by a recent finding that glucocorticoid levels (an indicator of stress) in SRKW correlated with an index of Chinook salmon availability (Ayres et al. 2012). Chinook salmon is overwhelmingly the most frequently consumed prey, of which 80-90% is from the Fraser River (Hanson et al 2010). The SRKW population may consume 12–23% of available Fraser River Chinook in the region from May–September, which might exceed takes from all fisheries in the region combined. As both species have at-risk conservation status and transboundary (Canada–U.S.) ranges, there could be competition between conservation objectives for killer whales and Chinook salmon (Williams et al. 2011). There are zero known fishery mortalities or serious injuries for this killer whale stock (Carretta et al. 2014).

Military operations are also potential sources of behavioral and habitat disturbance, injury, and mortality. The Northwest Testing Range Complex (NWTRC) includes the waters of Puget Sound (NMFS 2014f). Sonar, active acoustic sources, airguns, weapons firing, explosives, and vessel and aircraft noise could result in Level A or Level B harassment of some marine mammals, and vessel collisions and explosives could result in injury or mortality. The Navy coordinated with NMFS, through consultation and permitting processes, on mitigation measures (NMFS 2014f). The Navy’s exposure models estimate that no SRKW will be exposed to sonar and other non-impulsive acoustic stressors or to impulsive acoustic stressors associated with NWTRC training activities throughout the year (NMFS 2014f).

Climate change impacts are possible through changes in habitat and food availability. Migration, feeding, and breeding locations influenced by ocean currents and water temperature could be impacted, which could, ultimately, affect productivity of ESA-listed species (NMFS 2010b, NMFS 2011a). Contaminants, via runoff, discharge, or spills could also affect habitat integrity and prey resources. In addition, research conducted by other NMFS fisheries science centers, such as the Southwest Fisheries Science Center (SWFSC), occurs in some of the same areas affected by NWFSC research, and is therefore considered in the set of external factors that contribute to cumulative effects in the CCRA.

The activities external to NWFSC fisheries research affecting ESA-listed marine mammals in the PSRA are likely to continue into the foreseeable future (see Table 5.1-1). The level of impact will depend on the application and efficacy of current and proposed mitigation measures. The potential effects of climate change are unpredictable, but are also likely to continue into and beyond the foreseeable future.

Contribution of the Research Alternatives

Direct and indirect effects of the research alternatives on ESA-listed marine mammals are discussed in sections 4.2.4, 4.3.4, and 4.4.4. The three research alternatives considered in this DPEA include similar scopes of research. The primary differences lie in the number and types of associated mitigation measures for protected species.

There have been no reported vessel collisions or entanglements of ESA-listed marine mammals involving NWFSC vessels or gear in the PSRA. The level of ship traffic resulting from NWFSC fisheries research is miniscule compared to the number of other vessels transiting Puget Sound. Given the relatively slow speeds of research vessels, mitigation measures, and the small number of research cruises, the likelihood of fisheries research vessels causing serious injury or mortality to ESA-listed species due to ship strikes is low and the potential risk is minor.

The potential effects from use of active acoustic devices for research activities could elicit rare or infrequent and temporary behavioral avoidance effects on ESA-listed marine mammals. Relative to the

volume of other ship traffic and other anthropogenic sources of acoustic disturbance, the contribution of noise from NWFSC research would be minor.

There have been no known adverse interactions or takes of ESA-listed marine mammals during NWFSC fisheries research in the PSRA and Level A takes are not anticipated. Prey removal during fisheries research is very small and likely inconsequential to prey availability for SRKWs or any marine mammal species in the PSRA. When considered in conjunction with commercial and recreational fisheries and aggregated with other past, present, and reasonably foreseeable future activities affecting ESA-listed marine mammals in the PSRA, the contribution of NWFSC fisheries research activities to cumulative effects on ESA-listed marine mammals would be minor adverse under all three research alternatives.

Contribution of the No Research Alternative

Under the No Research Alternative, NWFSC would no longer conduct or fund the fisheries and ecosystem research considered in the scope of this DPEA, so would not directly contribute to cumulative effects on ESA-listed marine mammals in the PSRA. Indirectly, however, the loss of information obtained through this research on feeding ecology of ESA-listed marine mammals, oceanographic components of their habitat, and status of prey stocks could have minor to moderate adverse impacts on management decisions regarding the recovery of ESA-listed species and analysis of long-term trends affecting the marine ecosystem. The indirect contribution of the No Research Alternative to cumulative effects is difficult to ascertain for individual species, but could impact long-term monitoring and management capabilities in the region. When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting ESA-listed marine mammals in the NWFSC research areas, the contribution of the No Research Alternative to cumulative effects on ESA-listed marine mammals in the PSRA would be minor to moderate adverse.

5.5.2.2 Other Cetaceans

External Factors in the PSRA

The cetaceans included in this section are not ESA-listed, although they are subject to similar types of effects from external activities as described above for ESA-listed species. Baleen whales most common in the PSRA are minke whales and gray whales. Common odontocetes include harbor porpoises, Dall's porpoises, transient killer whales, and Pacific white-sided dolphins. The gray whale is the only species included in this section that was subjected to large-scale commercial whaling, as well as historical and current hunting for subsistence purposes. Details are as described above for the CCRA in Section 5.5.1.2. The NWFSC does not anticipate any Level A serious injury or mortality takes of gray whales or minke whale through fisheries research activities.

Interactions with commercial fisheries likely have the greatest effect on several species and are generally well-documented. Fisheries in which these species have been subject to mortality or serious injury in or near the PSRA include set gillnet fisheries (harbor porpoise), Washington/Oregon/California domestic groundfish trawl fishery (Dall's porpoise), and the Puget Sound salmon drift gillnet fishery (Dall's porpoise) (Carretta et al. 2014). The reported number of takes is less than 10 percent of the respective PBR levels for each of these species for which PBR is known, so population-level effects from commercial fishery takes are minor.

Ship strikes are a source of mortality for gray whales, although none of the 2.2 serious injuries or mortalities per year (2007-2011) attributed to ship strikes occurred within the PSRA (Carretta et al. 2014).

Military operations are also potential sources of behavioral and habitat disturbance, injury, and mortality. The Northwest Testing Range Complex (NWTRC) includes the waters of Puget Sound (NMFS 2014f). Sonar, active acoustic sources, airguns, weapons firing, explosives, and vessel and aircraft noise could

result in Level B harassment of several cetacean species. The Navy coordinated with NMFS, through consultation and permitting processes, on mitigation measures (NMFS 2012b, NMFS 2014f).

Climate change impacts are possible through changes in habitat and food availability. Migration, feeding, and breeding locations influenced by ocean currents and water temperature could be impacted, which could, ultimately, affect productivity of non ESA-listed cetacean species (NMFS 2010b, NMFS 2011a).

The activities external to NWFSC fisheries research affecting non ESA-listed cetaceans in the PSRA are likely to continue into the foreseeable future (see Table 5.1-1). The level of impact will depend on the application and efficacy of current and proposed mitigation measures. The potential effects of climate change are unpredictable, but are also likely to continue into and beyond the foreseeable future.

Contribution of the Research Alternatives

Direct and indirect effects of the research alternatives on non ESA-listed cetaceans are discussed in sections 4.2.4, 4.3.4, and 4.4.4. The three research alternatives considered in this DPEA include similar scopes of research. The primary differences lie in the number and types of associated mitigation measures for protected species. The contribution of NWFSC fisheries research activities to cumulative effects on non-ESA-listed cetaceans is likely to be small.

There have been no reported vessel collisions with cetaceans involving NWFSC vessels and the volume of ship traffic generated by NWFSC fisheries research is miniscule compared to the number of other vessels transiting the area. Given the relatively slow speeds of research vessels, mitigation measures, and the small number of research cruises, the likelihood of fisheries research vessels causing serious injury or mortality to non ESA-listed cetaceans due to ship strikes is considered possible, but the potential risk is minor.

Annual incidental take levels in external commercial fisheries exceed any known Level A takes by NWFSC fisheries research, which is zero for all cetaceans in the PSRA (Table 4.2-14). The estimated average annual takes of non-ESA-listed cetaceans by NWFSC in the next five years is well below 10 percent of PBR for almost all species for which takes are requested and PBR is known (Table 4.2-16) (see discussion in the CCRA section above). These estimates are based on historical takes of similar species in analogous commercial fisheries. The NWFSC does not think that number will actually be taken in the next five years, but used a conservative estimation procedure to ensure accounting for the maximum amount of potential take. According to the impact criteria described in Table 4.1-1, the level of mortality of the species considered here, if they occurred, would be considered minor in magnitude.

The potential effects from use of active acoustic devices for research activities would likely involve infrequent and temporary behavioral disturbance and avoidance effects (Level B harassment), particularly for the mid- and high-frequency hearing odontocetes, such as harbor porpoise. Relative to the volume of other ship traffic and anthropogenic sources of acoustic disturbance, the contribution of noise from NWFSC research would be minor.

Although there is some overlap in prey of non ESA-listed cetaceans and the species collected during NWFSC research surveys, surveys generally focus on younger age-classes than consumed by cetaceans and the total amount sampled is minimal compared to overall biomass and commercial fisheries removals. Prey removal during fisheries research is very small and likely inconsequential to prey availability for any marine mammal species. The contribution of research catches to the effects on cetaceans through competition for prey is therefore considered minor adverse.

When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting non-ESA-listed cetaceans in the PSRA, the contribution of the three research alternatives to cumulative effects on these species through disturbance and prey removal would be minor adverse.

Contribution of the No Research Alternative

Under the No Research Alternative, NWFSC would no longer conduct or fund the fisheries and ecosystem research considered in the scope of this DPEA, so would not directly contribute to cumulative effects on non ESA-listed cetaceans in the PSRA. Indirectly, however, the loss of information obtained through this research on marine mammal feeding ecology, oceanographic components of their habitat, and status of prey stocks could have minor to moderate adverse impacts on management decisions and analysis of long-term trends affecting the marine ecosystem. The indirect contribution of the No Research Alternative to cumulative effects is difficult to ascertain for individual species, but could impact long-term monitoring and management capabilities for cetaceans in the PSRA. When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting non ESA-listed cetaceans in the PSRA, the contribution of the No Research Alternative to cumulative effects would be minor to moderate adverse.

5.5.2.3 Other Pinnipeds

External Factors in the PSRA

Three species of non-ESA-listed pinnipeds commonly occur in the PSRA, including California sea lions, Steller sea lions (delisted in 2013), and harbor seals. These species are all subject to similar types of effects from external activities as described above for other species. Interactions with commercial fisheries likely have the greatest effect on most of these species and are also generally well-documented.

Fisheries in which California sea lions and Steller sea lions have been subject to mortality or serious injury are almost exclusively in the CCRA and are detailed above in Section 5.5.1.3. Although small numbers of takes of California sea lions previously occurred in the Washington, Oregon, California and British Columbia salmon net pen fishery, there were no takes of California sea lions or Steller sea lions in commercial fisheries in the PSRA in recent years (2005-2009) (Allen and Angliss 2014, Carretta et al. 2014).

The Washington Inland Waters stocks (Hood Canal, Southern Puget Sound, Washington Northern Inland Waters) of harbor seals have been known to interact with several set gillnet, drift gillnet, salmon gillnet, and unknown fisheries in the PSRA. Several salmon gillnet fisheries have not been observed since 1994, so recent data (2007-2011) are from fisherman self-reports in the Northern Washington marine set and marine drift gillnet fisheries and from stranding data. Minimum total annual takes are >2.8, >0.2, and >1.0 for the Washington Northern Waters, Hood Canal, and Southern Puget Sound stocks, respectively (Carretta et al. 2014). Additional sources of human-caused mortality and serious injury for these inland waters stocks include entanglement in marine debris, gunshot wounds, boat strikes, dog attacks, and oils spills (Carretta et al. 2014).

Pinnipeds in the PSRA have a diverse diet that includes adult salmonids, Pacific herring, gadids, and rockfish (Bromaghin et al. 2013). Many are valuable for commercial and recreational fisheries.

Military operations are also potential sources of behavioral and habitat disturbance, injury, and mortality. The Northwest Testing Range Complex (NWTRC) includes the waters of Puget Sound (NMFS 2014f). Sonar, active acoustic sources, airguns, weapons firing, explosives, and vessel and aircraft noise could result in Level A or Level B harassment of some pinnipeds, and vessel collisions and explosives could result in injury or mortality. The Navy coordinated with NMFS, through consultation and permitting processes, on mitigation measures (NMFS 2012b, NMFS 2014f).

Climate change impacts are difficult to predict, but may affect non ESA-listed pinnipeds through changes in habitat and food availability.

The activities external to NWFSC fisheries research affecting pinnipeds are likely to continue into the foreseeable future (see Table 5.1-1). The level of impact will depend on the application and efficacy of current and proposed mitigation measures. The potential effects of climate change are unpredictable, but are also likely to continue into and beyond the foreseeable future.

Contribution of the Research Alternatives

Direct and indirect effects of the NWFSC research alternatives on pinnipeds are discussed in sections 4.2.4, 4.3.4, and 4.4.4. The three research alternatives considered in this DPEA include similar scopes of research. The primary differences lie in the number and types of associated mitigation measures for protected species. The contribution of NWFSC fisheries research activities to cumulative effects on pinnipeds is likely to be small.

There have been no reported vessel collisions with pinnipeds involving NWFSC vessels in the PSRA and the volume of ship traffic generated by NWFSC fisheries research is a very small fraction of the total number of other vessels transiting the area. Given the relatively slow speeds of research vessels, mitigation measures, and the low number of research cruises, the likelihood of fisheries research vessels causing serious injury or mortality to non ESA-listed pinnipeds due to ship strikes is possible, but the potential risk is minor.

The potential effects from use of active acoustic devices for research activities could infrequently and temporarily elicit behavioral avoidance effects on pinnipeds in the PSRA. Relative to the volume of other ship traffic and other anthropogenic sources of acoustic disturbance, the contribution of noise from NWFSC research would be minor.

Incidental take in external commercial fisheries throughout the ranges of the pinnipeds considered here exceeds any known or potential Level A takes by NWFSC fisheries research (Tables 4.2-13 and 4.2-15). There were zero takes of California sea lions and Steller sea lions and one take of a harbor seal that was released alive during NWFSC fisheries research activities in the PSRA between 1999 and 2014. The estimated average annual take of California sea lions, Steller sea lions, and harbor seals by NWFSC in surface trawls and purse seines over the next five years is less than 0.1 percent of PBR for species and stocks for which PBR has been determined. The contribution of NWFSC fisheries research takes to cumulative effects on these species, if they occur, would be considered minor adverse.

Although there is some overlap in prey of non ESA-listed pinnipeds in the PSRA and the species collected during NWFSC research surveys, surveys generally focus on younger age-classes than consumed by pinnipeds and the total amount sampled is minimal compared to overall biomass and commercial fisheries removals. Prey removal during fisheries research is very small and likely inconsequential to prey availability for any marine mammal species. The contribution of research catches to the effects on marine mammals through competition for prey is therefore considered minor adverse for pinnipeds in the PSRA.

When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting non-ESA-listed pinnipeds in the PSRA, the contribution of the NWFSC fisheries research in the PSRA to cumulative effects on these species through disturbance, direct takes, and prey removal would be minor adverse under all three research alternatives.

Contribution of the No Research Alternative

Under the No Research Alternative, NWFSC would no longer conduct or fund the fisheries and ecosystem research considered in the scope of this DPEA, so would not directly contribute to cumulative effects on non-ESA-listed pinnipeds in the PSRA. Indirectly, however, the loss of information obtained through this research on feeding ecology, oceanographic components of their habitat, and status of prey stocks could have minor to moderate adverse impacts on management decisions regarding pinnipeds and

long-term trends affecting the marine ecosystem. When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting pinnipeds in the PSRA, the contribution of the No Research Alternative to cumulative effects on pinnipeds would be minor to moderate adverse.

5.5.3 Lower Columbia River Research Area

Activities external to NWFSC research that may potentially affect marine mammals in the LCRRA include commercial fisheries, vessel traffic, other scientific research, conservation measures (including deterrence and removal of nuisance sea lions), and climate change. These activities and potential effects are summarized in Table 5.1.1 and include:

- Disturbance/behavioral changes or physical effects from anthropogenic noise and intentional deterrence actions and removals
- Injury or mortality due to vessel collisions, entanglement in fishing gear, and contamination of the marine and riverine environments
- Changes in food availability due to prey removal, ecosystem change, or habitat degradation

5.5.3.1 ESA-listed Species

External Factors in the LCRRA

The endangered marine mammal species in the LCRRA include occasional sightings of SRKW at the mouth of the Columbia River. Steller sea lions, previously listed as threatened, were removed from the List of Threatened and Endangered Species in November 2013 and are now included below under Other Pinnipeds.

Due to the rarity of ESA-listed species in the LCRRA, further discussion is not warranted here. External factors likely to contribute to cumulative effects on marine mammals in the LCRRA are described below under Section 5.5.3.3.

Contribution of the Research Alternatives

Direct and indirect effects of the research alternatives on ESA-listed marine mammals in the LCRRA are discussed in sections 4.2.4, 4.3.4, and 4.4.4. The three research alternatives considered in this DPEA include similar scopes of research. The primary differences lie in the number and types of associated mitigation measures for protected species.

There have been no reported takes of ESA-listed marine mammals during NWFSC fisheries research in the LCRRA and the NWFSC is not requesting any takes for the five-year LOA application period. Active acoustic systems are not used during research in the LCRRA, so there are also no acoustic takes estimated. The rarity with which ESA-listed species occur in or near the LCRRA, the lack of historical takes, and the lack of anticipated takes suggest any potential contribution of NWFSC fisheries research activities to cumulative effects on ESA-listed marine mammals in the LCRRA would, at most, be minor adverse under all three research alternatives.

Contribution of the No Research Alternative

Under the No Research Alternative, NWFSC would no longer conduct or fund the fisheries and ecosystem research considered in the scope of this DPEA, so would not directly contribute to cumulative effects on ESA-listed marine mammals in the LCRRA. Indirectly, however, the loss of information obtained through research on ecosystem monitoring and status and habitat use of potential prey stocks could have minor to moderate adverse impacts on management decisions. Yet since the occurrence of currently-listed marine mammals in the LCRRA is rare and the likelihood of interactions is low, the

contribution of the No Research Alternative to cumulative effects on ESA-listed marine mammals would be minor adverse.

5.5.3.2 Other Cetaceans

External Factors in the LCRRA

No cetaceans occur with any regularity in the LCRRA, although there have been incidental takes in commercial fisheries in the lower reaches of the LCRRA. The external effects of these species are dominated by effects in the CCRA, which are described in section 5.5.1.2.

Contribution of the Research Alternatives

Direct and indirect effects of the research alternatives on non ESA-listed cetaceans are discussed in sections 4.2.4, 4.3.4, and 4.4.4. The three research alternatives considered in this DPEA include similar scopes of research. The primary differences lie in the number and types of associated mitigation measures for protected species. The contribution of NWFSC fisheries research activities to cumulative effects on non-ESA-listed cetaceans is likely to be small.

There have been no reported vessel collisions with cetaceans involving NWFSC vessels and the volume of ship traffic generated by NWFSC fisheries research is miniscule compared to the number of other vessels transiting the area. Given the relatively slow speeds of research vessels, mitigation measures, and the small number of research cruises, the likelihood of fisheries research vessels causing serious injury or mortality to non ESA-listed cetaceans due to ship strikes is considered possible, but the potential risk is minor.

Annual incidental take levels in external commercial fisheries exceed any known Level A takes by NWFSC fisheries research in the LCRRA (Table 4.2-14). The estimated average annual takes of harbor porpoise by NWFSC in the next five years is well below 10 percent of PBR (Table 4.2-16). These estimates are based on historical takes of this species in analogous commercial fisheries. The NWFSC does not think that number will actually be taken in the next five years, but used a conservative estimation procedure to ensure accounting for the maximum amount of potential take. According to the impact criteria described in Table 4.1-1, the level of mortality of this species, if it occurred, would be considered minor in magnitude.

Contribution of the No Research Alternative

Under the No Research Alternative, NWFSC would no longer conduct or fund the fisheries and ecosystem research considered in the scope of this DPEA, so would not directly contribute to cumulative effects on non ESA-listed cetaceans in the LCRRA. Indirectly, however, the loss of information obtained through this research on marine mammal feeding ecology, oceanographic components of their habitat, and status of prey stocks could have minor to moderate adverse impacts on management decisions and analysis of long-term trends affecting the marine ecosystem. The indirect contribution of the No Research Alternative to cumulative effects is difficult to ascertain for individual species, but could impact long-term monitoring and management capabilities for cetaceans in the LCRRA. When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting non ESA-listed cetaceans in the LCRRA, the contribution of the No Research Alternative to cumulative effects would be minor to moderate adverse.

5.5.3.3 Other Pinnipeds

External Factors in the LCRRA

Three species of non-ESA-listed pinnipeds commonly occur in the LCRRA, including California sea lions, Steller sea lions (delisted in 2013), and harbor seals. These species are all subject to similar types of effects from external activities as described above in the introduction to section 5.5.3. Interactions with commercial fisheries likely have the greatest effect on these species, with most likely occurring outside of the LCRRA and in the CCRA. Types and levels of take are, therefore, as described in Section 5.5.1.3. Male California sea lions tagged with satellite-linked transmitters in the Columbia River exhibited seasonal movements along the outer coast from Washington State to central California (Wright et al. 2010), areas where fisheries interactions may occur.

Deterrence and removal of “nuisance” animals at the Bonneville Dam result in behavioral disturbance and mortality of pinnipeds (primarily California sea lions) in that portion of the LCRRA. Physical barriers are used to keep pinnipeds out of fishways at the Dam (Stansell et al. 2014). In addition, Oregon Department of Fish and Wildlife (ODFW) and Washington Department of Fish and Wildlife (WDFW) trap and brand sea lions at Bonneville Dam and remove California sea lions that meet qualification for removal. In 2014, 36 California sea lions were captured. Fifteen of those were euthanized and the remaining 21 were branded and released. All Steller sea lions that were captured were released (Stansell et al 2014). Between 2008 and 2010, 40 California sea lions were removed (30 lethal removals and 10 relocations to aquaria and/or zoos), for an annual average removal rate of 17 animals during that period (Carretta et al. 2014). The U.S. Department of Agriculture (USDA) and Columbia River Inter-Tribal Fish Commission (CRITFC) use non-lethal harassment (hazing) techniques that include boat chasing, above-water pyrotechnics (cracker shells), rubber buckshot from shotguns, and underwater percussive devices (seal bombs) to deter predation. Hazing temporarily moved some sea lions, but they generally returned after the hazers left the area (Stansell et al 2014).

Climate change impacts are difficult to predict, but may affect non ESA-listed pinnipeds through changes in habitat and food availability.

The activities external to NWFSC fisheries research affecting pinnipeds are likely to continue into the foreseeable future (see Table 5.1-1). The level of impact will depend on the application and efficacy of current and proposed mitigation measures. The potential effects of climate change are unpredictable, but are also likely to continue into and beyond the foreseeable future.

Contribution of the Research Alternatives

Direct and indirect effects of the NWFSC research alternatives on pinnipeds are discussed in sections 4.2.4, 4.3.4, and 4.4.4. The three research alternatives considered in this DPEA include similar scopes of research. The primary differences lie in the number and types of associated mitigation measures for protected species. The contribution of NWFSC fisheries research activities to cumulative effects on pinnipeds is likely to be small.

There have been no reported vessel collisions with pinnipeds involving NWFSC vessels in the LCRRA and the volume of ship traffic generated by NWFSC fisheries research is a very small fraction of the total number of other vessels transiting the area. Given the relatively slow speeds of research vessels, mitigation measures, and the low number of research cruises, the likelihood of fisheries research vessels causing serious injury or mortality to non ESA-listed pinnipeds due to ship strikes is possible, but the potential risk is minor.

Active acoustic systems are not used during research in the LCRRA, so there are also no acoustic takes estimated.

Incidental take in external commercial fisheries throughout the ranges of the pinnipeds considered here exceeds any known or potential Level A takes by NWFSC fisheries research (Tables 4.2-13 and 4.2-15). The estimated take of one each of California sea lion, Steller sea lion, and harbor seal by NWFSC in surface trawls and purse seines/tangle nets over the next five years is less than 0.1 percent of PBR for species and stocks for which PBR has been determined. The contribution of NWFSC fisheries research takes to cumulative effects on these species, if they occur, would be considered minor adverse.

Although there is some overlap in prey of pinnipeds in the PSRA and the species collected during NWFSC research surveys, surveys generally focus on younger age-classes than consumed by pinnipeds. Prey removal during fisheries research is very small and likely inconsequential to prey availability for any marine mammal species. The contribution of research catches to the effects on marine mammals through competition for prey is therefore considered minor adverse for pinnipeds in the LCRRA.

When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting non-ESA-listed pinnipeds in the LCRRA, the contribution of the NWFSC fisheries research in the LCRRA to cumulative effects on these species through disturbance, direct takes, and prey removal would be minor adverse under all three research alternatives.

Contribution of the No Research Alternative

Under the No Research Alternative, NWFSC would no longer conduct or fund the fisheries and ecosystem research considered in the scope of this DPEA, so would not directly contribute to cumulative effects on non-ESA-listed pinnipeds in the LCRRA. Indirectly, however, the loss of information obtained through research on ecosystem monitoring and status and habitat use of potential prey stocks could have minor to moderate adverse impacts on management decisions regarding pinnipeds. When considered in conjunction with other past, present, and reasonably foreseeable future activities affecting pinnipeds in the LCRRA, the contribution of the No Research Alternative to cumulative effects on pinnipeds would be minor to moderate adverse.

5.6 CUMULATIVE EFFECTS ON BIRDS

Activities external to NWFSC fisheries research that could potentially affect birds in the NWFSC research area may include commercial and recreational fisheries, ocean disposal and discharges, dredging, coastal development, other scientific research, military operations, climate change, and ocean acidification. The potential effects of these activities are summarized in Table 5.1-1 and may include:

- Mortality from by-catch in fisheries and hunting
- Collisions with ships
- Alteration or reduction of prey resources
- Loss or injury due to ingestion of or entanglement in marine debris
- Behavioral disturbance
- Loss or injury due to contamination of habitat or prey
- Loss or injury from collision with offshore structures

5.6.1 California Current Research Area

5.6.1.1 External Factors in the CCRA

Seabirds in the CCRA are affected by numerous past and present human-caused and natural factors.

Anthropogenic factors include: mortality in longline and gill-net fisheries, ingestion of plastic debris, human use and development of nesting habitat, oil spills, attraction to and disorientation by artificial lights leading to exhausted birds landing in dangerous situations and colliding with power lines and other structures, habitat destruction, predation by non-native terrestrial mammals, nesting habitat loss and degradation from guano mining and invasive species, pollution, competition with fisheries for prey species, underwater explosions from industrial and military operations, entanglement in debris, ingestion of marine debris, vessel collisions, and hunting. Some seabird species travel long distances over the ocean and have many potentially adverse interactions with humans and their activities, such as commercial and recreational fisheries, and oil spills from transport vessels and offshore oil wells. Human activities on land can also affect them at sea or at inland nest sites, such as oil and gas exploration, coastal development and transportation, dock construction, marine pollution, and dredging, as well as agricultural and urban runoff contamination and land clearing for resource development. Climate change is also likely having effects on seabirds through changes in their prey abundance and distribution, although climate change may have adverse effects on some species while others may actually benefit.

Natural factors include: threats to their nesting habitat on coasts and islands, predation on adults, eggs, and young by birds and mammals, and habitat loss due to encroachment of vegetation. Natural factors such as changes in ocean currents, prey availability, and severe weather can drive population fluctuations for many species (Ainley and Hyrenbach 2007).

The factors that have affected seabirds in the CCRA in the past are likely to do so in the future. Reasonably foreseeable future actions include continuation and possible expansion of fisheries activities, military operations, oil and gas exploration and production, marine vessel traffic, ocean disposal and discharge, climate change, and ocean acidification.

For some species (e.g., ESA-listed species), cumulative effects resulting from external anthropogenic factors (past actions, present actions, and RFFAs) have caused declines in populations that are considered major conservation concerns. For many other species, population trends are not well known and most

populations tend to fluctuate normally due to natural factors. Cumulative effects on these species from anthropogenic sources could be minor.

5.6.1.2 Contribution of the Research Alternatives

None of the three research alternatives are likely to contribute more than minor adverse effects to the cumulative effects on seabirds. Seabird mortality during NWFSC fisheries research and removal of potential seabird prey is very small and localized. In contrast, ecosystem research conducted by the NWFSC has beneficial contributions to seabirds by providing scientific information important to seabird conservation and management. When considered in conjunction with commercial and recreational fisheries and aggregated with other past, present, and reasonably foreseeable future activities affecting seabirds in the Northwest, the contribution of NWFSC fisheries research to the cumulative effects on seabirds in the CCRA is considered minor adverse for all species.

5.6.1.3 Contribution of the No Research Alternative

The lack of research under this alternative would eliminate any direct effects on seabirds in the CCRA. However, some of the NWFSC projects that would be eliminated under this alternative include bird observers as part of the cruise operations or opportunistically when space is available and generate a great deal of information on the abundance, distribution, and feeding behaviors of seabirds in the CCRA. The loss of this information could indirectly affect resource management decisions concerning the conservation of seabirds. There are too many unknown variables to estimate the level of impact this lack of information would have on any particular species of seabirds but the contribution of this alternative to cumulative impacts on seabirds in the CCRA would likely be minor adverse.

5.6.2 Puget Sound Research Area

5.6.2.1 External Factors in the PSRA

Seabirds in the PSRA are being affected by the same types of anthropogenic and natural factors described above in the CCRA section, and are likely to be affected by the same types of RFFAs. The cumulative effects on seabirds in the PSRA resulting from external anthropogenic factors (past actions, present actions, and RFFAs) are considered major for some ESA-listed species to minor for other species.

5.6.2.2 Contribution of the Research Alternatives

None of the three research alternatives are likely to contribute more than minor effects to the cumulative effects on seabirds. No seabirds have ever been caught incidentally in NWFSC fisheries surveys in the PSRA and the risk is very low in the future. Removal of potential seabird prey is very small and localized. When considered in conjunction with commercial and recreational fisheries and aggregated with other past, present, and reasonably foreseeable future activities affecting seabirds in the Northwest, the contribution of NWFSC fisheries research to the cumulative effects on seabirds in the PSRA is considered minor adverse for all species.

5.6.2.3 Contribution of the No Research Alternative

As described above in the CCRA section, the contribution of this alternative to cumulative impacts on seabirds would be minor through the loss of ecological information used for the management and conservation of seabirds.

5.6.3 Lower Columbia River Research Area

5.6.3.1 External Factors in the LCRRA

Seabirds in the LCRRA are being affected by the same types of anthropogenic and natural factors described above in the CCRA section, and are likely to be affected by the same types of RFFAs. An additional action that has occurred the last several years in the LCRRA, and is reasonably certain to continue, is management actions taken by the U.S. Army Corps of Engineers (Corps) to reduce the predation rate of Caspian terns and double-crested cormorants on ESA-listed salmon smolts. These birds are currently nesting on islands composed of dredge spoils in the Columbia River Delta. The Corps has used and/or proposes to use a range of methods to reduce or disperse the populations of these birds, including efforts to enhance populations of their predators such as glaucous-winged and western gulls.

In a recently released environmental assessment the Corps proposes to continue the management of Caspian terns that began in 2000 as a project to socially attract the Caspian terns nesting on Rice Island to East Sand Island further downriver (USACE 2014). Since then the Corps has attempted redistribution of approximately 60 percent of the East Sand Island colony population via construction of new habitat (islands) in Oregon, California, and Washington. Over the last 4 years, the Corps has constructed 8.3 acres of new habitat to compensate for habitat reduction which has occurred naturally over that time on East Sand Island. In addition, Caspian terns are hazed annually on Rice Island, Pillar Rock Island, and Miller Sands Spit upstream of East Sand Island.

An EIS is currently being prepared by the Corps for management of double-crested cormorants on East Sand Island, with the intent of reducing the number of cormorant nesters. The Corps is proposing management methods that include: reducing nesting habitat, hazing during the nesting season to prevent colony establishment, and lethal components (collection of eggs, nests and/or potential take of adults).

These management actions have contributed to cumulative effects on seabirds, and may continue to in the future if the actions are continued. Species affected include double-crested cormorants, Caspian terns, glaucous-winged gulls, western gulls, and other seabirds throughout the LCRRA.

The cumulative effects on seabirds in the LCRRA resulting from external anthropogenic factors (past actions, present actions, and RFFAs) are considered major to moderate for heavily managed species (double-crested cormorants, Caspian terns and western and glaucous-winged gulls) to minor (other species).

5.6.3.2 Contribution of the Research Alternatives

None of the research alternatives are likely to contribute more than minor effects to the cumulative effects on seabirds. No seabirds have ever been caught incidentally in NWFSC fisheries surveys in the LCRRA and are not likely to be caught in the future. Removal of potential seabird prey is very small and localized. When considered in conjunction with commercial and recreational fisheries and aggregated with other past, present, and reasonably foreseeable future activities affecting seabirds in the Northwest, the contribution of NWFSC fisheries research to the cumulative effects on seabirds in the LCRRA is considered minor adverse for all species.

5.6.3.3 Contribution of the No Research Alternative

As described above in the CCRA section, the contribution of this alternative to cumulative impacts on seabirds would be minor adverse through the loss of ecological information used for the management and conservation of seabirds.

5.7 CUMULATIVE EFFECTS ON SEA TURTLES

Sea turtles are rarely encountered in the PSRA and LCRRA so the following analysis will focus on cumulative effects in the CCRA. Activities external to NWFSC fisheries research that could potentially affect sea turtles within the CCRA may include commercial and recreational fisheries, ocean disposal and discharges, dredging, coastal development, other scientific research, military operations, climate change, and ocean acidification. The potential effects of these activities are summarized in Table 5.1-1 and may include:

- Mortality and injury from by-catch in fisheries
- Collisions with ships
- Alteration or reduction of prey resources through fisheries and climate change
- Loss or injury due to ingestion of or entanglement in marine debris
- Behavioral disturbance from marine vessels and coastal development

5.7.1 California Current Research Area

5.7.1.1 External Factors in the CCRA

Sea turtles are susceptible to impacts resulting from natural and anthropogenic factors, both on land and in the water (Table 5.1-1). Effects on breeding beaches involve habitat degradation, injury, and mortality through numerous mechanisms: beach erosion, beach armoring and nourishment, artificial lighting, increases in human presence, beach cleaning, recreational beach equipment, beach driving, coastal construction, fishing piers, disturbance of dunes and beach vegetation, and poaching. Increases in human presence near nesting beaches have led to the introduction of exotic fire ants, dogs, raccoons, and armadillos, all of which may feed on turtle eggs. Adverse impacts to sea turtles also involve habitat degradation, injury, and mortality through numerous mechanisms: oil and gas exploration, coastal development and transportation, dock construction, marine pollution, dredging, underwater explosions, offshore artificial lighting, entanglement in debris, ingestion of marine debris, fishery interactions, boat collisions, and poaching.

Threats to sea turtles in the CCRA include incidental capture, injury, and mortality during commercial fishing operations. This conservation issue has been the subject of numerous conservation engineering studies. The implementation of turtle excluder devices and time/area restrictions in commercial trawl fisheries has reduced the level of captures and mortality in trawl fisheries. Use of circle hooks instead of 'J' hooks in commercial pelagic longline fisheries has also reduced sea turtle mortalities. However, capture and entanglement in several types of fishing gear continues to be a major conservation concern (NMFS and USFWS 1995).

Multiple past and present actions have affected sea turtles in the CCRA and many of these impact producing factors are likely to continue for the foreseeable future. All species of sea turtles that occur in the NWFSC research areas are threatened or endangered, and have therefore been subject to major population-level cumulative effects.

5.7.1.2 Contribution of the Research Alternatives

Fisheries research activities conducted and funded by the NWFSC have had no recorded interactions with any sea turtles and removal of potential sea turtle prey is very small and localized. None of the research alternatives are likely to contribute more than minor adverse effects to the cumulative effects on these species. In contrast, ecosystem research conducted by the NWFSC has beneficial contributions to sea turtles by providing scientific information important to sea turtle conservation and management. When

considered in conjunction with commercial and recreational fisheries and aggregated with other past, present, and reasonably foreseeable future activities affecting seabirds in the Northwest, the contribution of NWFSC fisheries research to the cumulative effects on sea turtles in the CCRA is considered minor adverse for all species.

5.7.1.3 Contribution of the No Research Alternative

The No Research Alternative would eliminate any direct impacts to sea turtles that could potentially occur under the research alternatives. However, the elimination of NWFSC fisheries research would also substantially reduce the collection of oceanographic and fisheries data important for monitoring the ecological status of the environment important to sea turtles. NWFSC research has also supported management and conservation of designated leatherback critical habitat. Under the No Research Alternative, the loss of information currently provided by NWFSC research activities would have a minor to moderate contribution to adverse cumulative impacts to sea turtles in the CCRA through indirect effects on management decisions important to the conservation and recovery of these species.

5.8 CUMULATIVE EFFECTS ON INVERTEBRATES

Activities external to NWFSC fisheries research that could potentially affect invertebrates in the CCRA, PSRA, and LCRRA may include commercial and recreational fisheries, ocean disposal and discharges, dredging, coastal development, oil extraction, other scientific research, military operations, climate change, and ocean acidification. The potential effects of these activities are summarized in Table 5.1-1 and may include:

- Injury or mortality due to directed catch or bycatch in commercial and recreational fisheries
- Benthic habitat disturbances
- Changes in survival and reproductive success due to climate change or habitat degradation

5.8.1 External Factors in the CCRA, PSRA, and LCRRA

Marine invertebrates continue to be susceptible to natural and anthropogenic effects including exploitation through commercial and recreational fishing, habitat degradation and disturbance, pollution, competition with invasive species, and climate change. Because marine invertebrates do not regulate their body temperature, changes in water temperature may affect the distribution of certain species as well as growth rates, reproductive ability and survival (Harley et al. 2006). In addition, ocean acidification is expected to have adverse effects on invertebrate species that form calcium carbonate shells or exoskeletons.

Compared to other regions in the U.S., the Pacific coast from California to Oregon has a narrow continental shelf, which may result in coral communities being more susceptible to coastal activities. Some activities that may adversely affect corals include oil and gas development, deployment of gas pipelines and communication cables, and marine pollution. However, fishing operations, particularly bottom trawling, pose the most immediate and widespread threats to deep coral communities (Whitmire and Clarke 2007).

Degradation of invertebrate habitat can occur as a result of commercial and recreational fisheries that involve gear coming into contact with the sea floor (See Section 4.2.7.3). Other sources of habitat disruption identified in the RFFAs (Table 5.1-1) include ocean dredging, waste disposal, and offshore development projects such as oil and gas development and wave or tidal power plants. In addition, pollution can adversely affect the quality of water and benthic habitats upon which invertebrates depend. Effects of pollution may include decreased foraging ability and reproductive success and increased mortality (Milligan et al. 2009). Most accidental discharges are likely to be small and localized but some accidental discharges with large vessels or industrial activities may affect large geographic areas and impact benthic habitats for years.

Overexploitation of undersized or immature individuals can have serious implications for the sustainability of stocks, and the overall body size of individuals in a fished population may also change with intense fishing pressure on a single size (Donaldson et al. 2010). Some commercially valuable species of invertebrates (e.g. abalone) have had population declines in the past due to overharvest. Commercial fishing is likely to be the dominant factor in cumulative effects on these species in the future, although climate change may also have substantial effects on some species.

5.8.2 Contribution of the Research Alternatives

The direct and indirect effects of the research alternatives on invertebrates are discussed in sections 4.2.7, 4.3.7, and 4.4.7. NWFSC research activities remove small amounts of invertebrates from all three research areas, primarily in the CCRA. Federally or state-managed invertebrate species that are caught in

the NWFSC research activities include ocean pink shrimp, market squid, and Dungeness crab. Mortality resulting from NWFSC fisheries research would make minor contributions to adverse cumulative effects on invertebrates under each of the research alternatives. Because the NWFSC does not use bottom-trawl gear in the LCRRA, NWFSC research there would not contribute to benthic habitat disturbance in that area. The NWFSC does use bottom-trawl gear in the CCRA and PSRA, which would make a minor additive contribution to adverse cumulative effects on benthic invertebrate habitat. The contributions of NWFSC research activities to habitat contamination, climate change, and ocean acidification are expected to be so minor as to be discountable.

NWFSC fisheries research would also have beneficial contributions to future fisheries management decisions related to invertebrate populations in the CCRA, PSRA, and LCRRA and would help to address a range of adverse cumulative effects. When considered in conjunction with commercial and recreational fisheries and aggregated with other past, present, and reasonably foreseeable future activities affecting invertebrate species along the U.S. West Coast, the direct contribution of NWFSC research activities to cumulative effects on invertebrates would be minor and potentially adverse under each of the research alternatives.

5.8.3 Contribution of the No Research Alternative

Under the No Research Alternative, the NWFSC would no longer conduct or fund fieldwork for fisheries and ecosystem research in the CCRA, PSRA, and LCRRA, so would not directly contribute to cumulative effects on invertebrate species in this region. However, in the absence of NWFSC research surveys and bycatch reduction research, important scientific information would not be collected about the status of invertebrate stocks or the efficacy of different gear modifications. As is the case with commercially valuable fish stocks, this type of information is used for fisheries and conservation management, including the long-term monitoring of stock assessments, trends in abundance, recruitment rates, and the amount of invertebrates being harvested relative to overfishing metrics. This lack of data would make it much more difficult for fisheries managers to effectively monitor the status of stocks, develop fishery regulations, rebuild depleted stocks, and monitor effects of ecosystem changes. The lack of information and increasing uncertainty about the status of invertebrate stocks and their habitats would have serious implications for fisheries management. The indirect effects of the No Research Alternative could, therefore, adversely impact invertebrate stocks through a lack of information essential for prudent decision making and conservation of invertebrates and their habitats. The indirect contribution of the No Research Alternative to cumulative effects on commercially valuable invertebrate species is difficult to ascertain but will likely have minor to moderate adverse impacts on the long-term monitoring ability of NMFS or other agencies and the management capabilities for numerous economically and ecologically important species.

5.9 CUMULATIVE EFFECTS ON THE SOCIAL AND ECONOMIC ENVIRONMENT

5.9.1 California Current Research Area

5.9.1.1 External factors in the CCRA

This section describes the contribution of NWFSC research activities to cumulative effects on the social and economic environment from past, present, and reasonably foreseeable future actions (RFFA). The cumulative effects of fisheries research and management associated with the CCRA are closely related to socioeconomic conditions in Washington, Oregon, and California. Overall, California's economy had a gross state product of about \$1.9 trillion in 2010, characterized by great diversity among economic sectors (U.S. Department of Commerce 2010). Potential future socioeconomic cumulative effects from developments in non-fishing industries, such as liquid natural gas terminals, oil extraction, shipping commerce, or climate change cannot be feasibly estimated with available data, but would be expected to dominate the economy in the future.

In regard to fishing opportunity, cumulative fishing and non-fishing industry actions would be more noticeable in coastal communities. Specific fisheries management decisions, to which the NWFSC research program contributes, could also have an effect over time. Reductions in certain stocks as a result of ocean ecosystem changes, or overfishing, which results in commercial or recreational area closures, would result in noticeable changes in the socioeconomic status of communities.

RFFAs that could contribute to cumulative effects to the social and economic environment include updates to species take reduction plans, and fishery management measures. Species take reduction plans could include measures that would lead to increased costs for fishermen through required gear modifications. These plans could also call for time and/or area closures that could affect fishing fleet locations.

5.9.1.2 Contribution of the research alternatives

The fundamental purpose of fisheries management is to monitor and counteract the contribution of commercial and sport fishing to the adverse cumulative effects on fish stocks from past, present, and reasonably foreseeable actions. NWFSC research is one of the most effective mechanisms to monitor the status of fish stocks and changes in the marine environment, providing substantial beneficial contributions to cumulative effects through scientific input to fishery management and other environmental decision-making processes. Continuation of this research would provide consistent data to allow evaluation of fish stock trends and the effects of actions not related to fishing.

In all research alternatives, at-sea and laboratory research, and cooperative fisheries management activities that are currently directed by NWFSC would continue. This would help promote sustainable fish populations and have substantial benefits for local economies dependent on stable fishing opportunities. Long-term sustainable catches would be promoted, increasing stability in the fishing communities and reducing boom and bust cycles related to over-exploitation of target species.

In addition, research results that identify effects not related to commercial or recreational fishing that could threaten species recoveries and sustainable yield levels would be identified in sufficient time to take corrective action before population level effects would be noticed by fishers in the form of reduced abundance and lower catches. The cumulative effect to the social and economic environment of U.S. West Coast fisheries as a result of Alternatives 1 and 2 would be beneficial and moderate to major in magnitude. Mitigation measures in Alternative 3 that reduce the ability of the NWFSC to sample commercial fish and invertebrate stocks in certain places and times could represent a slightly reduced benefit, as at-sea sampling operations would be reduced from the current level of comprehensiveness.

The socioeconomic effects of non-fishing industry actions are likely to dominate any cumulative effects on the socioeconomic environment of the CCRA. The research alternatives would contribute minor to moderate (beneficial) effects to the cumulative effects because the NWFSC research provides a substantial portion of the information needed to determine if fisheries management actions are successful, and therefore balance the needs for stock recovery and sustainable catch quotas that minimize impacts to fishing communities. The at-sea surveys also provide measures to detect the result of cumulative changes contributed by non-fishing industries and climate change. The contribution of the research alternatives to cumulative effects on the socioeconomic environment would be minor to moderate and beneficial in that it reduces the potential for negative cumulative effects on commercial and recreational fisheries.

5.9.1.3 Contribution of the No Research Alternative

Under the No Research Alternative, the NWFSC would not contribute to the information base needed for sustainable fisheries management. Fisheries research activities conducted by state and private organizations are not likely to be sufficient to identify trends in target fish stocks and set sustainable fishery harvest limits without the contribution from the NWFSC. Some major commercial species would likely receive attention from state and private research efforts, so potential adverse effects would not likely be uniform across the fishing communities. Some fishers that target these major species may continue to benefit from sustainable fisheries management, but others may be affected by lack of information on their target species. Lack of consistent data input into the fisheries management process would have adverse effects on the quality of the management analyses, and subsequently to the value of the management process. Elimination of at-sea operations would reduce science-based input into fisheries management decisions, which would increase the potential for negative cumulative effects on commercial fisheries.

The No Research Alternative would contribute minor to moderate adverse effects to the cumulative effects on the socioeconomic environment because at-sea research efforts of the NWFSC that could detect and anticipate cumulative effects on fisheries resources, which are important for fisheries management decisions that strongly influence the socioeconomic conditions of fishing communities, would not be conducted.

5.9.2 Puget Sound Research Area

5.9.2.1 External factors in the PSRA

RFFAs associated with both fishing and non-fishing industries, and climate change, have the potential to affect national and international socioeconomic dynamics. Puget Sound is the second-largest estuary in the United States, located in northwest Washington State, covering an area with an abundance of shorelines and major river systems, as well as being home to a rapidly-expanding human population. The cumulative effects on social and economic issues for fishing communities and related industries in Washington and the PSRA closely parallel the effects on fisheries management. These include both natural activities and trends such as climate change (including changes in ocean characteristics), and anthropogenic activities associated with offshore development, contamination, and commercial and sport fishing.

Based on the Puget Sound Regional Council's (PSRC) 2012 Regional Economic Strategy, the maritime industry contributes significantly to the region with around \$5 billion in sales annually. It includes a variety of industrial and service-related activities, including commercial fishing, seafood processing, passenger transportation, ship and boat building, marine support industries, deep and shallow draft water transportation, and public sector operations. "The strength of central Puget Sound's maritime industry lies in its size and diversity. In addition to its substantial maritime infrastructure, the region is home to a high concentration of expertise connected to the industry." (PSCRC, 2012)

While the impacts on the future development of non-fishing industries in Puget Sound cannot be easily estimated; the impacts on fishing related industries could be more noticeable in small, fishing oriented, coastal communities within the PSRA.

Since the communities in the PSRA are dependent on the abundance and location of commercially exploitable fish and invertebrates, factors that influence fish stocks also influence the economic well-being of the fishing communities. Therefore, the historical effects of overfishing and the resultant declines in fish stocks, followed by the imposition of sometimes severe limits under FMPs has had major adverse social and economic effects on the fishing communities.

RFFAs that could contribute to cumulative effects on the social and economic environment of the PSRA include updates to species take reduction plans, new conservation measures for sea turtles and new fishery management measures that may come into effect. Species take reduction plans could include measures that would lead to increased costs for fishermen through required gear modifications. These plans could also call for time and/or area closures that would have short-term effects to fishing fleets having to alter their fishing locations. The potential effects of climate change on fisheries stocks and distribution is another RFFA of concern.

Existing fisheries regulations within the West Coast Region have already contributed to effects on the social and economic environment through numerous regulatory regimes affecting levels of effort for both commercial and recreational fishing. Most fishermen can understand the need to protect different marine species. However, depending on locations of closed areas or the level of specificity in regulations, fishermen could feel varying levels of effects on their daily operations from these regulations.

5.9.2.2 Contribution of the research alternatives

The management of commercial and recreational fisheries would continue to be supported by the proposed fisheries research conducted and funded by the NWFSC. This would help promote sustainable fish populations and have substantial benefits for local economies dependent on stable fishing opportunities. Long-term sustainable catches would be promoted, increasing stability in the fishing communities and reducing boom and bust cycles related to over-exploitation of target species.

Research results contributing to the understanding of effects not related to commercial or recreational fishing that could threaten species recoveries and sustainable yield levels would be identified in sufficient time to take corrective action before population level effects would be noticed by fishers in the form of reduced abundance and lower catches. This includes potential effects of climate change and ocean acidification.

Finally, fisheries research creates jobs and purchases services in fishing communities. Depending on the community, this is a minor to moderate beneficial contribution to cumulative effects. In the case of the PSRA, the cumulative effects on the socioeconomic characteristics of the communities within the research area would also be minor to moderate and beneficial.

The importance of federally managed fisheries in the social and economic environment of Northwest communities varies substantially from place to place. When combined with past, present, and RFFAs, the cumulative effect to the social and economic environment of the NWFSC research alternatives would be minor to moderate and beneficial. Implementation of the research alternatives would have a beneficial contribution to these cumulative effects by supporting science-based, sustainable fisheries management and providing information important to the assessment of potential effects on fisheries resources from climate change and resource development projects.

5.9.2.3 Contribution of the No Research Alternative

Under the No Research Alternative, the NWFSC would not contribute to the information base needed for sustainable fisheries management in the PSRA. Fisheries research activities conducted by state and private organizations are not likely to be sufficient to identify trends in target fish stocks and set sustainable fishery harvest limits without the contribution from the NWFSC. Some major commercial species would likely receive attention from state and private research efforts, so potential adverse effects would not likely be uniform across the fishing communities. Some fishers that target these major species may continue to benefit from sustainable fisheries management, but others may be affected by lack of information on their target species. Lack of consistent data input into the fisheries management process would have adverse effects on the quality of the management analyses, and subsequently to the value of the management process. Elimination of at-sea operations would reduce science-based input into fisheries management decisions, which would increase the potential for negative cumulative effects on commercial fisheries.

The No Research Alternative would contribute minor to moderate adverse effects to the cumulative effects on the socioeconomic environment because at-sea research efforts of the NWFSC that could detect and anticipate cumulative effects on fisheries resources, which are important for fisheries management decisions that strongly influence the socioeconomic conditions of fishing communities, would not be conducted.

5.9.3 Lower Columbia River Research Area

5.9.3.1 External factors in the LCRRA

RFFAs associated with both fishing and non-fishing industries, and climate change, have the potential to affect economic dynamics, in a region extending from Washington's southern coast and inland up the Columbia River towards Portland. The cumulative effects of activities on the LCRRA are similar to those discussed for the PSRA in Section 5.9.2. Any impacts caused by external factors would be focused towards individual research sites specifically and not the entire research area. As with the PSRA, communities in the LCRRA are dependent on the abundance and location of commercially exploitable fish and invertebrates. The factors that influence fish stocks also influence the economic well-being of the fishing communities. The effects of overfishing and the resultant declines in fish stocks, followed by the imposition of sometimes severe limits under FMPs can have major adverse social and economic effects on the fishing communities. RFFAs that could contribute to cumulative effects on the social and economic environment of the LCRRA include updates to FMPs, as well as new conservation measures and fishery management measures that may come into effect.

The contribution of NWFSC research to the cumulative effects of socio-economics in the LCRRA are the same as those discussed for the PSRA in Section 5.2.9 and are considered minor adverse.

5.9.3.2 Contribution of the research alternatives

The cumulative effects for the LCRRA under the research alternatives would have a similar impact on socioeconomic cumulative effects as described for the PSRA. The differences between alternatives on cumulative effects are minor due to the extent of economic activity occurring in the LCRRA. Fishing has a minor impact on the socioeconomics of the area in relation to other economic activities within the LCRRA, but site specific research locations may have larger impacts on localized socioeconomics. All research alternatives support continued sustainable fisheries management and would result in socioeconomic activities at similar or existing levels. When combined with past, present, and RFFAs, the cumulative effect to the social and economic environment of the NWFSC research alternatives would be minor to moderate and beneficial.

5.9.3.3 Contribution of the No Research Alternative

The No Research Alternative would result in elimination of any direct impacts to the LCRRA that could potentially occur under each of the research alternatives. Without the input of NWFSC data, management authorities would lack important information needed to effectively manage and conserve resources of socioeconomic significance. NWFSC research efforts within the LCRRA could help detect and anticipate cumulative effects on fisheries resources, which are important for fisheries management decisions that strongly influence the socioeconomic conditions of fishing communities in the area. Under the No Research Alternative, this important research would not be conducted. Through these indirect effects on future management decisions, the contribution of this alternative to cumulative impacts on socioeconomic resources would be minor to moderate and adverse.

6.1 THE MAGNUSON-STEVENSON FISHERY CONSERVATION AND MANAGEMENT ACT

In 1976, Congress passed the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801, et seq.). This law authorizes the United States (U.S.) to manage its fishery resources in an area extending from the seaward boundary of a state's territorial sea (generally 3 nautical miles [5.6 kilometers] from shore) out to 200 nautical miles (370 kilometers) from shore. This area is termed the Exclusive Economic Zone (EEZ). The MSA was updated in 2006, and is now known as the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act.

Two of the main purposes of the MSA are to promote domestic commercial and recreational fishing under sound conservation and management principles, and to provide for fishery management plans (FMPs). The FMPs are intended to achieve and maintain, on a continuing basis, the optimum yield from each fishery. The MSA standards require that FMPs contain certain conservation and management measures. The standards include measures necessary to prevent overfishing; rebuilding overfished stocks; ensuring conservation; facilitating long-term protection of Essential Fish Habitat (EFH); and realizing the full potential of the nation's fishery resources. Furthermore, the MSA also declares that the National Fishery Conservation and Management Program must utilize the best scientific information available; involves, and is responsive to the needs of interested and affected states and citizens; considers efficiency; and draws upon federal, state, and academic capabilities in carrying out research, administration, management, and enforcement.

Certain stocks of fish have declined to the point where their survival is impacted, and other stocks of fish have been substantially reduced in number such that they could become similarly affected as a consequence of (a) increased fishing pressure, (b) the inadequacy of fishery resource conservation and management practices and controls, or (c) direct and indirect habitat losses which have resulted in a diminished capacity to support existing fishing levels.

The resource and research surveys conducted by the NWFSC are designed to meet the requirements of the MSA by providing the best scientific information available to fishery conservation and management scientists and managers. This supports a management program that is able to respond to changing ecosystem conditions, and manages risk by developing science-based decision tools.

The U.S. Commission on Ocean Policy has identified the need for more holistic assessments of the status of marine ecosystems. The President's Ocean Action Plan has endorsed the concept of marine Ecosystem-Based Management. Sustained ecosystem monitoring programs are essential for tracking the health of marine ecosystems as part of this overall approach. The individual NWFSC surveys comprise a broader ecosystem monitoring program that meets this emerging critical need.

The EFH provisions of the MSA require federal agencies to consult with National Marine Fisheries Service (NMFS) when their actions or activities may adversely affect habitat identified by regional fishery management councils or NMFS as EFH. In addition, NMFS must provide recommendations for conserving and enhancing EFH, which is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity". There is no EFH-specific permit or authorization process; EFH consultations can be combined with existing environmental review procedures, where appropriate, and are often combined with NEPA. The NWFSC has had discussions with the West Coast Region EFH Coordinator regarding assessment of impacts from NWFSC fisheries research activities on EFH.

Section 404 of the MSA requires the Secretary of Commerce to initiate and maintain, in cooperation with the Fishery Management Councils, a comprehensive program of fishery research to carry out and further the purposes, policy, and provisions of the MSA. Substantial parts of the proposed action meet the MSA's definition of scientific research activity, and the proposed action is part of a comprehensive program to

address this requirement. The MSA does not include scientific research as part of the definition of “fishing” regulated by the MSA.

The 1996 amendments to the MSA require assessment, specification, and description of the effects of conservation and management measures on participants in fisheries, and on fishing communities:

Conservation and management measures shall, consistent with the conservation requirements of this Act (including the prevention of overfishing and rebuilding of overfished stocks), take into account the importance of fishery resources to fishing communities in order to (A) provide for the sustained participation of such communities, and (B) to the extent practicable, minimize adverse economic impacts on such communities.

The Sustainable Fisheries Act of 1996 (Public Law 104-297) is also an amendment to the MSA. Sections 104 and 105 clarify issues surrounding highly migratory fish, and the international agreements that govern fisheries. Among the topics covered by these sections are fishing in international waters of the Atlantic and Pacific oceans; fishing in the Bering Sea, shared with Russia; and congressional rules setting time limits on approval of international fishing treaties. Sections 116 to 406 of the Sustainable Fisheries Act describe the management measures and research necessary to implement the act. These sections specify the agencies responsible for research and the nature of the research to be conducted in each of several specific fishing areas, including the Pacific Ocean.

6.2 MARINE MAMMAL PROTECTION ACT

The Marine Mammal Protection Act (MMPA) of 1972 (16 U.S.C. 1361 *et seq.*), as amended, prohibits the “take” of marine mammals in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and marine mammal products into the U.S. The primary management objective of the MMPA is to maintain the health and stability of the marine ecosystem, with a goal of obtaining an optimum sustainable population of marine mammals within the carrying capacity of the habitat. The MMPA is intended to work in concert with the provisions of the Endangered Species Act (ESA). The secretary is required to give full consideration to all factors regarding regulations applicable to the take¹³ of marine mammals, including the conservation, development, and utilization of fishery resources, and the economic and technological feasibility of implementing the regulations.

Section 101(a)(5)(A-D) of the MMPA provides a mechanism for allowing, upon request, the “incidental,” but not intentional, taking, of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing or directed research on marine mammals) within a specified geographic region. The NMFS Office of Protected Resources (OPR) processes applications for incidental takes of small numbers of marine mammals. Authorization for incidental takes may be granted if NMFS finds a negligible impact on the species or stock(s), and if the methods, mitigation, monitoring and reporting for takes are permissible.

The purpose of issuing incidental take authorizations is to provide an exemption to the take prohibition in the MMPA, and to ensure that the action complies with the MMPA and NMFS implementing regulations. ITAs may be issued as either: (1) regulations and associated Letters of Authorization (LOAs) under Section 101(a)(5)(A) of the MMPA; or (2) Incidental Harassment Authorizations (IHAs) under Section 101(a)(5)(D) of the MMPA. An IHA can only be issued when there is no potential for serious injury and/or mortality or where any such potential can be negated through required mitigation measures.

¹³ The MMPA defines take as: “to harass, hunt, capture, or kill, or attempt to harass, hunt, capture or kill any marine mammal.” Harassment means any act of pursuit, torment, or annoyance which, 1) has the potential to injure a marine mammal or marine mammal stock in the wild (Level A Harassment); or 2) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B Harassment).

Pursuant to Section 101(a)(5)(A) of the MMPA, NMFS, upon application from the NWFSC, may propose regulations to govern the unintentional taking of marine mammals, by harassment, incidental to the proposed fisheries research activities by the NWFSC in the Pacific Ocean. The issuance of MMPA incidental take regulations and associated LOAs to the NWFSC is a federal action, thereby requiring NMFS to analyze the effects of the action on the human environment pursuant to NEPA and NMFS NEPA procedures.

After an application is submitted, the NMFS OPR may authorize incidental takes of marine mammals through either a one-year IHA, or through LOAs, which may cover activities for up to five years. The NWFSC will be applying for an LOA for the small number of incidental takes of marine mammals that could occur during their fisheries research surveys. This DPEA will provide informational support for that LOA application and provide NEPA compliance for the authorization.

6.3 ENDANGERED SPECIES ACT

The Endangered Species Act (ESA) of 1973 as amended (16 U.S.C. 1531, *et seq.*), provides for the conservation of endangered and threatened species of fish, wildlife, and plants. The statute is administered jointly by NMFS and the USFWS, with some exceptions - NMFS oversees marine mammal species, marine and anadromous fish species, and marine plant species; and the USFWS oversees walrus, sea otter, seabird species, and terrestrial and freshwater wildlife and plant species.

The listing of a species as threatened or endangered is based on the biological health of that species. Threatened species are those likely to become endangered in the foreseeable future (16 U.S.C. 1532[20]). Endangered species are those in danger of becoming extinct throughout all or a significant portion of their range (16 U.S.C. 1532[20]). Species can be listed as endangered without first being listed as threatened.

In addition to listing species under the ESA, the appropriate expert agency (NMFS or USFWS) must designate critical habitat of the newly listed species within a year of its listing to the “maximum extent prudent and determinable” (16 U.S.C. 1533[b] [1] [A]). The ESA defines critical habitat as those specific areas that are essential to the conservation of a listed species and that may be in need of special consideration. Federal agencies are prohibited from undertaking actions that destroy or adversely modify designated critical habitat. Some species, primarily cetaceans (whales), which were listed in 1969 under the Endangered Species Conservation Act and carried forward as endangered under the ESA, have not received critical habitat designations.

Federal agencies have an affirmative mandate to conserve listed species. An assurance of this is that federal actions, activities, or authorizations must be in compliance with the provisions of the ESA. Section 7 of the ESA provides a mechanism for consultation by the federal action agency with the appropriate expert agency. Informal consultations are conducted for federal actions that have no adverse effects on the listed species and typically result in letters of concurrence from the expert agency. In cases where a proposed action may affect listed species or critical habitat, the action agency prepares a biological assessment to determine if a proposed action would adversely affect listed species or modify critical habitat. The biological assessment contains an analysis based on biological studies of the likely effects of the action on the species or habitat. The expert agency either concurs with the assessment or provides its own analysis to continue the consultation.

If the action agency or expert agency concludes that a proposed action may have adverse effects on a listed species, including take¹⁴ of any listed species, they must enter formal consultations under Section 7

¹⁴ The ESA defines take as: to “harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct.” (16 U.S.C. 1538[a][1][B])

of the ESA. The expert agency must then write a Biological Opinion (BiOp) that determines whether a proposed action places the listed species in jeopardy of extinction or adversely modifies its critical habitat. If the BiOp concludes the proposed (or ongoing) action will cause jeopardy to the species or adversely modify its critical habitat, it must also include reasonable and prudent alternatives that would modify the action so it no longer poses jeopardy to the listed species. These reasonable and prudent alternatives must be incorporated into the federal action if it is to proceed. Regardless of whether the BiOp reaches a jeopardy or no jeopardy conclusion, it often contains a series of mandatory and/or recommended management measures the action agency must implement to further reduce the negative impacts to the listed species and critical habitat (50 CFR 402.24[j]). If a proposed action would likely involve the taking of any listed species, the expert agency may append an incidental take statement to the BiOp to authorize the amount of take that is expected to occur from normal promulgation of the action. The NWFSC will use this DPEA to initiate Section 7 consultation on the proposed action with the Protected Resource Offices of both NMFS and USFWS.

Section 4(f) of the ESA directs NMFS to develop and implement recovery plans for threatened and endangered species, unless such a plan would not promote conservation of the species. According to the statute, these plans must incorporate, at a minimum:

- a description of site-specific management actions necessary to achieve recovery of the species
- objective, measurable criteria which, when met, would result in a determination that the species be removed from the list
- estimates of the time and costs required to achieve the plan's goal
- Section 7 of the ESA requires consultation with affected Native American treaty tribes when a decision regarding the species of concern can affect their treaty rights.
- Section 10 provides for the services (NMFS or USFWS) to permit incidental takes of listed species, for specified reasons, in accordance with the statute.

NMFS Program on Cooperative Conservation with States (section 6 of the ESA) was developed to assist states that have a cooperative agreement with NMFS in developing and implementing their conservation program for species listed in that agreement, including providing funding for management, research and monitoring that has a direct conservation benefit to the species. Conservation actions may also be carried out by federal agencies as part of their obligations under section 7(a)(1) of the ESA, or as a means to minimize activities that adversely affect a species as part of an interagency consultation. States, local agencies and private entities may conduct conservation actions as a means to minimize or mitigate "incidental take" of species as part of a Conservation Plan under section 10 of the ESA.

In order to meet these requirements and to support recovery plan development, the NWFSC conducts research aimed at determining recovery criteria and assessing threats that may potentially impede the recovery of threatened and endangered species. In addition, these activities enable NMFS, state and local agencies, and private entities to fulfill the conservation requirements outlined within the ESA.

6.4 MIGRATORY BIRD TREATY ACT

The Migratory Bird Treaty Act (MBTA) protects approximately 836 species of migratory bird species from any attempt at hunting, pursuing, wounding, killing, possessing, or transporting any migratory bird, nest, egg, or part thereof, unless permitted by regulations (i.e. for hunting and subsistence activities). Additional protection is allotted under the Bald and Golden Eagle Protection Act for the identified species. Compliance with the MBTA does not require a permit or authorization; however, the USFWS often requests that other agencies incorporate MBTA mitigation measures as stipulations in their permits. In addition, a Draft Memorandum of Understanding (MOU) between NMFS and USFWS focuses on avoiding and minimizing, to the extent practicable, adverse impacts on migratory birds through enhanced

interagency collaboration. In compliance with the MOU, the NWFSC has identified and evaluated the impacts of the proposed actions on migratory birds. NMFS will provide a copy of this DPEA to the USFWS and will consider all comments from USFWS concerning compliance with the MBTA as necessary.

6.5 FISH AND WILDLIFE COORDINATION ACT

The Fish and Wildlife Coordination Act (FWCA) requires USFWS and NMFS to consult with other state and federal agencies in a broad range of situations to help conserve fish and wildlife populations and habitats in cases where federal actions affect natural water bodies (16 U.S.C. 661 1934). Specific provisions involve conservation or expansion of migratory bird habitats related to water body impoundments or other modifications. FWCA requires consultation among agencies and the incorporation of recommended conservation measures if feasible, but does not involve a separate permit or authorization process. NMFS will provide a copy of this DPEA to the state fish and wildlife agencies in every state affected by the fisheries research activities examined in this DPEA. NMFS will consider all comments from these agencies and take steps to comply with FWCA as necessary.

6.6 NATIONAL HISTORIC PRESERVATION ACT

Section 106 of the National Historic Preservation Act (NHPA) requires review of any project funded, licensed, permitted, or assisted by the federal government for impact on significant historic properties. Federal agencies must allow the State Historic Preservation Officer (SHPO) and the Advisory Council on Historic Preservation, a federal agency, to comment on a project. NMFS will provide a copy of this DPEA to the SHPOs in every state affected by the fisheries research activities examined in this DPEA. NMFS will consider all comments from the SHPOs and take steps to comply with NHPA.

6.7 EXECUTIVE ORDER 13158, MARINE PROTECTED AREAS

The purpose of this order is to strengthen and expand the Nation's system of marine protected areas (MPAs) to enhance the conservation of our Nation's natural and cultural marine heritage and the ecologically and economically sustainable use of the marine environment for future generations. The order encourages federal agencies to use science-based criteria and protocols to identify and prioritize natural and cultural resources in the marine environment that should be protected to secure valuable ecological services and to monitor and evaluate the effectiveness of MPAs. Each federal agency whose actions affect the natural or cultural resources that are protected by an MPA shall identify such actions. To the extent permitted by law and to the maximum extent practicable, each federal agency, in taking such actions, shall avoid harm to the natural and cultural resources that are protected by an MPA.

6.8 EXECUTIVE ORDER 12989, ENVIRONMENTAL JUSTICE

Executive Order 12988 directs federal agencies to take the appropriate and necessary steps to identify and address disproportionately high and adverse effects of federal projects on the health or environment of minority and low-income populations to the greatest extent practicable and permitted by law. No such effects are identified in this DPEA.

6.9 INFORMATION QUALITY ACT

Pursuant to NOAA guidelines implementing Section 515 of Public Law 106-554 (the Data Quality Act), all information products released to the public must first undergo a Pre-Dissemination Review to ensure and maximize the quality, objectivity, utility, and integrity of the information (including statistical information) disseminated by or for federal agencies. The following sections address these requirements.

6.9.1 Utility

The information presented in this document is helpful to the intended users (the affected public) by presenting a clear description of the purpose and need of a proposed action, the measures proposed, and the impacts of those measures. This document is the principal means by which the information contained herein is available to the public. The information provided in this document is based on the most recent available information from the relevant data sources. The development of this document and the decisions made by NMFS to propose an action are the result of a multi-stage public process. This document is available in several formats, including printed publication and CD-ROM, upon request.

6.9.2 Integrity

Prior to dissemination, information associated with an action, independent of the specific intended distribution mechanism, is safeguarded from improper access, modification, or destruction, to a degree commensurate with the risk and magnitude of harm that could result from the loss, misuse, or unauthorized access to or modification of such information. All electronic information disseminated by NMFS adheres to the standards set out in Appendix III, “Security of Automated Information Resources,” of Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Act. All confidential information (e.g., dealer purchase reports) is safeguarded pursuant to the Privacy Act; Titles 13, 15, and 22 of the U.S.C. (confidentiality of census, business, and financial information); the Confidentiality of Statistics provisions of the MSA; and NAO 216-100, Protection of Confidential Fisheries Statistics.

6.9.3 Objectivity

For purposes of the Pre-Dissemination Review, this document is considered to be a “Natural Resource Plan.” Accordingly, the document adheres to the published standards of the MSA; Operational Guidelines of the FMP Process; EFH Guidelines; National Standard Guidelines; and NAO 216-6, Environmental Review Procedures for Implementing NEPA.

This document uses information of known quality from sources acceptable to the relevant scientific and technical communities. Stock status (including estimates of biomass and fishing mortality) are based on either assessments subject to peer-review through Stock Assessment Review Committees or on updates of those assessments prepared by scientists of the NWFSC. Landing information is based on information collected through the NWFSC Commercial Fisheries database. In addition to these sources, other information is presented that has been accepted and published in peer-reviewed journals or by scientific organizations.

Despite current data limitations, the measures proposed for this action were selected based upon the best scientific information available. The analyses conducted in support of the proposed action were conducted using information from the most recent complete calendar years. The data used in the analyses provide the best available information on the landings of the relevant species in the NWFSC region.

The supporting science and analyses, upon which the policy choices are based, have been documented. All supporting materials, information, data, and analyses within this document have been, to the maximum extent practicable, properly referenced according to commonly accepted standards for scientific literature to ensure transparency.

The review process used in preparation of this document involved staff from the NWFSC and NOAA Fisheries West Coast Region. The NWFSC’s technical review was conducted by senior level scientists with specialties in population dynamics, stock assessment methods, demersal resources, population biology, and the social sciences. All stock assessment data used in this document have been subjected to the Stock Assessment Workshop/Stock Assessment Review Committee review process. Review was conducted by those with expertise in fisheries management and policy, habitat conservation, protected species, and compliance with the applicable law.

6.10 EXECUTIVE ORDER 13112, INVASIVE SPECIES

This order (64 CFR 6183, February 3, 1999) directs federal agencies to prevent the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause. The Executive Order established the National Invasive Species Council.

6.11 NATIONAL MARINE SANCTUARIES ACT

The Marine Protection, Research and Sanctuaries Act (MPRSA) (16 U.S.C. 1431) prohibits all ocean dumping (except that allowed by permits) in any ocean waters under U.S. jurisdiction, by any U.S. vessel, or by any vessel sailing from a U.S. port. MPRSA authorizes the Secretary of Commerce (through NOAA) to coordinate a research and monitoring program with the EPA and the U.S. Coast Guard (USCG). The MPRSA established nine regional marine research boards for the purpose of developing comprehensive marine research plans, considering water quality and ecosystem conditions and research and monitoring priorities and objectives in each region. It also launched a national coastal water quality monitoring program that directs the EPA and NOAA together to implement a long-term program to collect and analyze scientific data on the environmental quality of coastal ecosystems, including ambient water quality, health and quality of living resources, sources of environmental degradation, and data on trends. Results of these actions are used to provide the information required to devise and execute effective programs under the Clean Water Act and Coastal Zone Management Act (CZMA).

The National Marine Sanctuaries Act (also known as Title III of the MPRSA) authorizes the Secretary of Commerce to designate and protect areas of the marine environment with special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archeological, educational, or esthetic qualities as national marine sanctuaries. The primary objective is to protect marine resources, such as coral reefs, sunken historical vessels or unique habitats.

Section 304(d) requires interagency consultation between the NOAA Office of National Marine Sanctuaries and federal agencies taking actions that are “likely to destroy, cause the loss of, or injure a sanctuary resource.” In compliance with the MPRSA, the NWFSC has identified and evaluated the impacts of the proposed actions on National Marine Sanctuaries. NMFS will provide a copy of this DPEA to the Office of National Marine Sanctuaries and will consider all comments from them concerning compliance with the MPRSA as necessary.

6.12 COASTAL ZONE MANAGEMENT ACT

The principal objective of the CZMA is to encourage and assist states in developing coastal management programs, to coordinate state activities, and to safeguard regional and national interest in the coastal zone. Section 307(c) of the CZMA requires federal activity affecting the land or water uses or natural resources of a state’s coastal zone to be consistent with that state’s approved coastal management program, to the maximum extent practicable. NMFS will provide a copy of this DPEA and a consistency determination to the state coastal management agency in every state with a federally-approved coastal management program whose coastal uses or resources are affected by these fisheries research activities. Each state has sixty days in which to agree or disagree with the determination regarding consistency with that state’s approved coastal management program. If a state fails to respond within sixty days, the state’s agreement may be presumed.

6.13 PACIFIC INTERNATIONAL CONVENTIONS, TREATIES, AND LAWS

The NWFSC participates in international forums for the assessment of the status of some stocks in accordance with the relevant rules of international law. NMFS, working through the NWFSC, conducts research to support U.S. commitments to international fisheries management, including provision of stock assessment and management advice for the conventions and treaties outlined below.

6.13.1 Tunas Convention Act

The Tunas Convention Act of 1950 (16 U.S.C. 951-961; Act of September 7, 1950, as amended) addresses and codifies the obligations of the U.S. under the Inter-American Tropical Tuna Commission (IATTC) and authorizes the Secretary of Commerce to issue regulations for implementing recommendations of the Commission. The act permits limiting the size and quantity of catches and limiting or prohibiting incidental catch of regulated species.

The IATTC was established in 1949 to monitor the long-term conservation and sustainable use of tunas, billfish, dolphins, turtles, non-target finfish, sharks, and others) that may be affected either directly or indirectly by fishing operations. In 2003, the Convention's scope was broadened, and is now known as the Antigua Convention. The Antigua Convention applies to waters of the Pacific Ocean including areas off California, Oregon and Washington, and encompasses significant U.S. fisheries, such as the troll fishery targeting albacore. The IATTC is currently made up of 21 nations and fishing entities. The Secretary of Commerce has directed NMFS to conduct research and provide scientific input into stock assessments and conservation and management recommendations for target and non-target stocks in the convention area.

The International Scientific Committee for Tuna and Tuna-like Species (ISC) in the North Pacific Ocean was established in 1995 for the purpose of enhancing scientific research and cooperation for conservation and rational utilization of tuna and tuna-like species of the North Pacific Ocean. Through a Memorandum of Understanding, the ISC provides scientific support for the work of the Northern Committee of the WCPFC. As a member, the U.S. supports obligations to the Committee through scientific research conducted by NMFS.

6.13.2 Pacific Salmon Treaty Act

The Pacific Salmon Treaty Act [Public Law 99–5, Approved Mar. 15, 1985, 99 Stat. 7, amended through Public Law 111–8, Enacted March 11, 2009] was established to balance fishing and conservation interests between the U.S. and Canada to prevent overfishing and provide for optimum production. It was also designed to benefit both countries in receiving benefits of salmon originating in their respective waters. The Pacific Salmon Commission was established to implement the Treaty, and is composed of federal and state officials; Washington, Idaho, Alaska, and Oregon residents, and tribal representatives.

6.13.3 International Whaling Commission

The International Convention for the Regulation of Whaling was established in 1946. The International Whaling Commission is composed of members of 89 countries. In 1986 the Commission introduced zero catch limits for commercial whaling, which remains to present. The Commission sets catch limits for aboriginal subsistence whaling. It also addresses the conservation of whales, and promotes the recovery of depleted whale populations by reviewing ship strikes or entanglement events, habitat, and protocols for whalewatching. The Whaling Convention Act of 1949 (16 U.S.C. 916-9161; Act of August 9, 1950, as amended) authorizes the secretary of commerce via NOAA and NMFS to provide and collect scientific data, and enforce the provisions of the International Convention for the Regulation of Whaling and to issue regulations necessary for this purpose. The Makah Whaling Commission oversees whaling by members of the Makah tribe of Washington, and reports on activities to NOAA.

6.13.4 Fishermen's Protective Act

The Fishermen's Protective Act of 1967 (22 U.S.C. 1971-1980; Pub. L. 90-482, as amended) authorizes the Secretary of Commerce to establish an insurance fund for the reimbursement of owners or charterers of fishing vessels which incur damage, loss, or destruction while engaged in any fishery under U.S. exclusive management, or are damaged by a vessel other than a U.S. vessel. The 1971 Pelly Amendment to the Fishermen's Protective Act authorizes the Secretary of Commerce, upon determination that foreign

nationals are conducting fishing operations in a way that diminishes the effectiveness of international fishery conservation programs, to certify such to the President. The Secretary also has the responsibility to certify to the President when foreign nationals are engaging in trade or taking in a manner which diminishes the effectiveness of any international program for endangered or threatened species.

6.14 TRIBAL TREATIES AND CASE DECISIONS

Pursuant to Article VI of the United States Constitution, these treaties are the law of the land and may only be abrogated (per several U.S. Supreme Court decisions) by express language of Congress (cannot be inferred where a statute is silent). Regulations and policies may not abrogate treaty rights. Due Process is assured to these tribes federally through the 5th Amendment and by states because of the 14th Amendment.

In the Pacific Northwest and unique in the nation are the Stevens Treaty tribes, which have reserved their off-reservation rights to their respective lands and waters. Each is a separate and distinct political sovereign with reserved rights to make and enforce laws and regulations and employ management practices that govern their use and management of the natural resources that sustained their cultures and economies for countless generations over thousands of years. Tribal political sovereignty is recognized by not only because of the treaties with the United States, but also because of the federal case law defining them, and subsequent legislation (notably the replacement of the policy of Indian Termination with Native American Self Determination in the 1970s primarily through Public Law 93-638).

The marine ecosystem and associated natural resources form an essential foundation for the economies and cultures of the Treaty Tribes in Washington. Through treaties¹⁵ with the United States, the Tribes reserved hunting, fishing, and gathering rights to access and use the plants, mammals, fish and other resources of the their treaty areas, in perpetuity. These rights are exercised in each tribe's "usual and accustomed areas" (U&A), which collectively extend from Puget Sound into the open ocean from Point Chehalis on the south to the U.S./Canada border on the north. Treaty tribes in Washington are the only tribes in the United States with treaties that reserve their sovereign jurisdiction in marine areas and overlap with both state and federal ocean jurisdictions.

Since the late 1800s, the federal courts have been forced to intervene to protect tribal access to the resources and rights secured by treaties with the United States against interference. In 1974, the decision of the federal courts in the seminal case of *United States v. Washington* issued by Judge George Boldt (often referred to as the "Boldt" decision, *U. S. v. Washington*, 384 F. Supp. 312, 353 (W.D. Wash. 1974), *aff'd* 520 F.2d 676 (9th Cir. 1975), *aff'd sub nomem State of Washington et al. v. Washington State Commercial Passenger Fishing Vessel Association et al.* 443 U.S. 658, 99 Ct. 3055 (1979)) noted that:

"From the earliest known times, up to and beyond the time of the Stevens' treaties, the Indians comprising each of the treating tribes and bands were primarily a fishing, hunting, and gathering people dependent almost entirely upon the natural animal and vegetative resources of the region for their subsistence and culture." 384 F.Supp 312, 406 (W. D. Wash. 1974)

"The treaty-secured rights to resort to the usual and accustomed places to fish were a part of larger rights possessed by the treating Indians, upon the exercise of which there was not a shadow of impediment, and which were nor much less necessary to their existence than the atmosphere they breathed. The treaty was not a grant of rights to the treating Indians, but a grant

¹⁵ The 1855 Treaty of Neah Bay with the Makah Indian Tribe and the 1855 Treaty of Olympia with the Hoh Indian Tribe, Quileute Indian Tribe and the Quinault Indian Nation.

of rights from them, and a reservation of those not granted.” 384 F. Supp. 312, 407 (W. D. Wash. 1974).

Under the treaties and case law, treaty tribes are co-managers of shared ocean resources, along with Federal and State governments. The United States has the legal obligation and a trust responsibility to protect treaty rights and ensure that tribal access and use of the resources necessary to sustain their cultures, economies, and lifeways are maintained in perpetuity.

As political sovereigns, the Treaty Tribes have historically and traditionally enjoyed government-to-government relationships with the United States. Consultation and collaboration are the hallmarks of this relationship as most recently reaffirmed with Executive Order 13175 and the Presidential Memo of November 2009.

For decades government-to-government consultation with federally-recognized tribal sovereign nations has been required on any action that may affect tribal rights or interests as a matter of public policy. Only the tribes themselves are capable of determining when consultation is needed, but they must be accorded the opportunity to substantively engage in government-to-government dialogue with the United States prior to its taking action or establishing federal policies, rules or regulations that affect them.

The tribes are distinct political sovereigns, who enjoy unique government-to-government relationship with the United States. Through treaties, these tribes reserved all rights not expressly granted from them, including rights to fish, hunt, and gather natural resources. Essential to this right is the recognition that tribes are co-managers of the ocean environment. Therefore the tribes must be substantively involved in the development of policies, regulations, or plans which affect the resources within their U&As. The federal government and all its agencies and entities have the duty, responsibility, and obligation to consult potentially affected tribe(s) on any matter that may affect their rights or interests.

Executive Order (EO) 13175, Consultation and Coordination with Indian Tribal Governments, affirms the trust responsibility of the United States and directs agencies to consult with Native American tribes and to respect tribal sovereignty when tribal rights may be affected. Where NWFSC actions may affect tribal lands or treaty rights, the trust duty includes a substantive duty to protect tribal rights to the fullest extent possible. Tribal rights to harvest and manage marine resources inclusive of fisheries resources either on or off tribal lands have a significant influence on fisheries in the Northwest. Treaty language securing fishing and hunting rights is not a “grant of rights (from the federal government to the Indians), but a grant of rights from them—a reservation of those not granted” (United States v. Winans, 25 S. Ct. 662 (1905)).

- Abramson, L., S. Polefka, S. Hastings, and K. Bor. 2009. Reducing the threat of ship strikes on large cetaceans in the Santa Barbara Channel region and Channel Islands National Marine Sanctuary. Prepared and adopted by the Channel Islands National Marine Sanctuary Advisory Council. 73 pp. Available at: www.channelislands.noaa.gov.
- Adams, P.B., C. Grimes, J. E. Hightower, S. T. Lindley, M. L. Moser, and M. J. Parsley. 2007. Population status of North American green sturgeon *Acipenser medirostris*. *Environmental Biology of Fishes* 79:339–356.
- Aguilar, A. 2009. Fin whale *Balaenoptera physalus*. Pp. 433–437, *In* W.F. Perrin, B. Würsig, and H.G.M. Thewissen (eds.), *Encyclopedia of Marine Mammals*, Academic Press, San Diego, CA. 1316 pp.
- Ainley, D. G., D. N. Nettleship, H. R. Carter, and A. E. Storey. 2002. Common Murre (*Uria aalge*). *In* A. Poole and F. Gill (eds). *The birds of North America*, No. 666. The Birds of North America, Inc., Philadelphia, PA.
- Ainley, D.G., and K.D. Hyrenbach. 2007. Long- and short-term factors affecting seabird population trends in the California Current System 1985–2006. H.T. Harvey and Associates, CA.
- Alberto, L. Personal communication, as cited in Whitmire and Clarke 2007: Whitmire CE, Clarke E. 2007. State of deep coral ecosystems of the U.S. Pacific Coast: California to Washington. *In*: Lumsden SE, Hourigan TF, Bruckner AW, Dorr G, editors. *The State of Deep Coral Ecosystems of the United States NOAA Technical Memorandum CRCP-3*. p. 109–154. Available online: http://www.coris.noaa.gov/activities/deepcoral_rpt/Chapter3_PacificCoast.pdf.
- Al-Humaidhi, A.W. M.A. Bellman, J. Jannot, and J. Majewski. 2012. Observed and estimated total bycatch of green sturgeon and Pacific eulachon in 2002–2010 U.S. West Coast Fisheries. West Coast Groundfish Observer Program. National Marine Fisheries Service, NWFSC, 2725 Montlake Blvd E., Seattle, WA 98112.
- Alexander, R. et al. 2010. Signs of hope in the Eastern Pacific: international collaboration reveals encouraging status for the severely depleted population of Hawksbill Turtles *Eretmochelys imbricate*. *In* *Oryx – The International Journal of Conservation*. 2010 Fauna & Flora International, *Oryx*, 1–7.
- Allen, B.M., and R.P. Angliss. 2013. Alaska marine mammal stock assessments, 2012. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-245, 282 p.
- Allen, B.M., and R.P. Angliss. 2014. Alaska marine mammal stock assessments, 2013. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-277, 294 p.
- Allen, B.M. and R.P. Angliss. 2014b. Draft Alaska marine mammal stock assessments, 2014. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-XXX.
- Allen, S.J., J.A. Tyne, H.T. Kobryn, L. Bejder, K.H. Pollock, and N.R. Loneragan. 2014. Patterns of dolphin bycatch in a North-Western Australian trawl fishery. *PLoS ONE* 9(4): e93178. doi:10.1371/journal.pone.0093178
- American Bird Conservancy. 2011. Endangered short-tailed albatross killed by fishing boat off the coast of Oregon. Available online: <http://www.abcbirds.org/newsandreports/releases/110909.html>
- Arnould, J.P.Y. 2009. Southern fur seals *Arctocephalus* spp. pp 1079–1084, *in* W.F. Perrin, B. Würsig, and H.G.M. Thewissen (eds.), *Encyclopedia of Marine Mammals*, Academic Press, San Diego, CA. 1316 pp.

- Ayres, K.L., Rebecca K. B, Jennifer A.H., Kari L. K., Candice K. E, Robin W. B, Kelley B.B., M. B.H., Michael J.F., Samuel K.W. 2012. Distinguishing the Impacts of Inadequate Prey and Vessel Traffic on an Endangered Killer Whale (*Orcinus orca*) Population. PLoS ONE 7(6): e36842.
- Au, W.W.L. and M.C. Hastings. 2008. Principles of marine bioacoustics. New York: Springer.
- Auster, P. J. and R. W. Langton. 1999. The effects of fishing on fish habitat. In L. Benaka (ed.). Fish Habitat: Essential Fish Habitat and Rehabilitation. Am. Fish. Soc. Symp. 22:150-187.
- Baird, R.W., P.A. Abram, and L.M. Dill. 1992. Possible indirect interactions between transient and resident killer whales: implications for the evolution of foraging specialization in the genus *Orcinus*. *Oecologia* 89:125-132.
- Baird R.W. 2009. Risso's dolphin. In: Encyclopedia of marine mammals. In W.F. Perrin, B. Würsig, J.G.M. Theewissen (eds.). Academic Press, Amsterdam, pp. 975-976.
- Baraff, L. S. and T. R. Loughlin. 2000. Trends and potential interactions between pinnipeds and fisheries of New England and the U.S. west coast. *Mar. Fish. Rev.* 64(2): 1-39.
- Barlow, J. and R. Gisiner. 2006. Mitigating, monitoring and assessing the effects of anthropogenic sound on beaked whales. *J. Cetacean Res. Manage.* 7 (3): 239-250.
- Barlow, J. 2010. Cetacean abundance in the California current from a 2008 ship-based line-transect survey. NOAA Technical Memorandum, NMFS, NOAA-TM-NMFS-SWFSC-456.
- Barlow, L., and K.A. Forney. 2007. Abundance and population density of cetaceans in the California current ecosystem. *Fishery Bulletin, U.S.*, 105:509-526.
- Barlow, J., M. Kahru, B.G. Mitchell. 2008. Cetacean biomass, prey consumption, and primary production requirements in the California Current ecosystem. *Marine Ecology Progress Series* 371: 285-295.
- Belkin, I.M., P.C. Cornillon and K. Sherman. 2009. Fronts in large marine ecosystems. *Progress in Oceanography* 81(1-4): 223-236.
- Benson, S. R., T. Eguchi, D. G. Foley, K. A. Forney, H. Bailey, C. Hitipeuw, B. P. Samber, R. F. Tapilatu, V. Rei, P. Ramohia, J. Pita, and P. H. Dutton. 2011. Large-scale movements and high-use areas of Western Pacific leatherback turtles, *Dermochelys coriacea*. *Ecosphere* 2(7):art84. doi:10.1890/ES11-00053.1
- Berdeal, I.G., B.M. Hickey, and M. Kawase. 2002. Influence of wind stress and ambient flow on a high discharge river plume. *Journal of Geophysical Research* 107(C9):3130.
- BirdLife International. 2008. Seabird communities are declining in the southern Californian current system. Presented as part of the BirdLife State of the world's birds website. Available from: <http://www.birdlife.org/datazone/sowb/casestudy/115>. Checked: 13/05/2014
- Birdweb. 2013. Seattle audubon society's guide to birds of Washington state. Accessed via the internet at: www.birdweb.org on April 2, 2013.
- Bograd, S.J., W.J. Sydeman, J. Barlow, A. Booth, R.D. Brodeur, J. Calambokidis, F. Chavez, W.R. Crawford, E. Di Lorenzo, R. Durazo, R. Emmett, J. Field, G. Gaxiola-Castro, R. Gilly, R. Goericke, J. Hildebrand, J.E. Irvine, M. Kahru, J.A. Koslow, B. Lavaniegos, M. Lowry, D.L. Mackas, M. Manzano-Sarabia, S.M. McKinnell, B.G. Mitchell, L. Munger, R.I. Perry, W.T. Peterson, S. Ralston, J. Schweigert, A. Suntsov, R. Tanasichuk, A.C. Thomas, F. Whitney. 2010. Status and trends of the California Current region, 2003-2008, pp. 106-141 In S.M. McKinnell and M.J. Dagg (ds). *Marine ecosystems of the north pacific ocean. 2003-2008. PICES Special Publication* 4. 393 pp.

- Bower, J.L. 2009. Changes in marine bird abundance in the salish sea: 1975-2007. *Marine Ornithology* 37: 9-17.
- Bradburn, M.J., A.A. Keller, and B.H. Horness. 2011. The 2003 to 2008 U.S. West Coast bottom trawl surveys of groundfish resources off Washington, Oregon, and California: Estimates of distribution, abundance, length, and age composition. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-114, 323 p.
- Brennan, J.S., K.F. Higgins, J.R. Cordell, and V.A. Stamatiou. 2004. Juvenile salmon composition, timing, distribution, and diet in the marine nearshore waters of central Puget Sound in 2001-2002. King County Department of Natural Resources and Parks, Seattle, WA. 164 pp.
- Bromaghin, J.F., M.M. Lance, E.W. Elliot, S.J. Jeffries, A. Acevedo-Gutiérrez, and J.M. Kennish. 2013. New insights into the diets of Harbor Seals (*Phoca vitulina*) in the Salish Sea revealed by analysis of fatty acid signatures. *Fish. Bull.* 111:13-26.
- Brooke, M. L. de. 2004. *Albatrosses and Petrels Across the World*. Oxford University Press, Oxford.
- Burns, J. J. 2009. Harbor seal and spotted seal *Phoca vitulina* and *P. largha*. Pages 533-542, in W.F. Perrin, B. Wursig, and H.G.M. Thewissen (eds.). *Encyclopedia of Marine Mammals*, Academic Press, San Diego, CA. 1316 pages.
- Busby, J., C. Wainwright, J. Bryant, J. Lierheimer, S. Waples, F. Waknitz, and V. Lagomarsino. 1996. Status review of West Coast steelhead from Washington, Idaho, Oregon, and California. National Marine Fisheries Service Northwest Fisheries Science Center.
- Buscaino, G., A. Bellante, G. Buffa, F. Filiciotto, V. Maccarrone, G. Tranchida, and S. Mazzola. 2011. Depredation of striped dolphin on squid fishery and behavioral responses to interactive pinger. *J. Acoust. Soc. Am.* 129: 2399 <http://dx.doi.org/10.1121/1.3587805>
- Butler, J.L. et al. 2003. *Fishery Bulletin* (Seattle). 101:260-280.
- Cairns, S.D. (1983) A generic revision of the Stylasterina (Coelenterata: Hydrozoa), Part 1, Description of the genera. *Bulletin of Marine Science* 33:427–508.
- Calambokidis, J. and T. Chandler. 2000. Marine mammal observations and mitigation associated with USGS seismic surveys in the Southern California Bight in 2000. Final report. Cascadia Research, Olympia, WA. 13 pp.
- Calambokidis, J., E. Falcone, A. Douglas, L. Schlender, and J. Huggins. 2009. Photographic identification of humpback and blue whales off the U.S. West Coast: results and updated abundance estimates from 2008 field season. Final Report for Contract AB133F08SE2786 from Southwest Fisheries Science Center. 18pp.
- Calambokidis, J. and J. Barlow. 2013. Updated abundance estimates of blue and humpback whales off the U.S. west coast incorporating photo-identifications from 2010 and 2011. Document PSRG-2013-13 presented to the Pacific Scientific Review Group, April 2013. 7 p.
- Calambokidis, J. and G.H. Steiger. 1990. Sightings and movements of humpback whales in Puget Sound, Washington. *Northwestern Naturalist* 71:45-49.
- Calambokidis, J., G.H. Steiger, D.K. Ellifrit, B.L. Troutman and C.E. Bowlby. 2004. Distribution and abundance of humpback whales and other marine mammals off the northern Washington coast. *Fisheries Bulletin* 102(4):563-580.
- Calambokidis, J., E.A. Falcone, T.J. Quinn, A.M. Burdin, P.J. Clapham, J.K.B. Ford, C.M. Gabriele, R. LeDuc, D. Mattila, L. Rojas-Bracho, J.M. Straley, B.L. Taylor, J. Urbán, R.D. Weller, B.H. Witteveen, M. Yamaguchi, A. Bendlin, D. Camacho, K. Flynn, A. Havron, J. Huggins, and N. Maloney. 2008. SPLASH: Structure of populations, levels of abundance and status of humpback

- whales in the North Pacific. Final Report for Contract AB133F-03-RP-00078 by Cascadia Research, Olympia, WA for U.S. Department of Commerce. 57 pages.
- California Department of Fish and Game (CDFG). 2008. California bird species of special concern. Accessed on May 10, 2014 at <http://www.dfg.ca.gov/wildlife/nongame/ssc/birds.html>
- Carretta, J. V. and J. Barlow. 2011. Long-term effectiveness, failure rates, and "dinner bell" properties of acoustic pingers in a gillnet fishery. *Marine Technology Society Journal* 45(5): 7-19.
- Carretta, J.V., K.A. Forney, E. Oleson, K. Martien, M.M. Muto, M.S. Lowry, J. Barlow, J. Baker, B. Hanson, D. Lynch, L. Carswell, R.L. Brownell Jr., J. Robbins, D.K. Mattila, K. Ralls, and M.C. Hill. 2011. U.S. Pacific Marine Mammal Stock Assessments: 2009. U.S. Department of Commerce. NOAA Technical Memorandum NMFS-SWFSC-476. 352 pp.
- Carretta, J.V., K.A. Forney, E. Oleson, K. Martien, M.M. Muto, M.S. Lowry, J. Barlow, J. Baker, B. Hanson, D. Lynch, L. Carswell, R.L. Brownell Jr., J. Robbins, D.K. Mattila, K. Ralls, and Marie C. Hill. 2012. U.S. Pacific Marine Mammal Stock Assessments: 2011. U.S. Department of Commerce, NOAA Technical Memorandum, NMFS-SWFSC-488, 356 p.
- Carretta, J.V., E. Oleson, D.W. Weller, A.R. Lang, K.A. Forney, J. Baker, B. Hanson, K. Martien, M.M. Muto, M.S. Lowry, J. Barlow, D. Lynch, L. Carswell, R. L. Brownell Jr., D. K. Mattila, and M.C. Hill. 2013. U.S. Pacific Marine Mammal Stock Assessments: 2012. U.S. Department of Commerce, NOAA Technical Memorandum, NMFS-SWFSC-504. 378 p.
- Carretta, J.V., E. Oleson, D.W. Weller, A.R. Lang, K.A. Forney, J. Baker, B. Hanson, K. Martien, M.M. Muto, A.J. Orr, H. Huber, M.S. Lowry, J. Barlow, D. Lynch, L. Carswell, R. L. Brownell Jr., and D. K. Mattila. 2014. U.S. Pacific Marine Mammal Stock Assessments: 2013. U.S. Department of Commerce, NOAA Technical Memorandum, NMFS-SWFSC-532. 406 p.
- Carretta, J.V., E. Oleson, D.W. Weller, A.R. Lang, K.A. Forney, J. Baker, B. Hanson, K. Martien, M.M. Muto, A.J. Orr, H. Huber, M.S. Lowry, J. Barlow, J.E. Moore, D. Lynch, L. Carswell, R.L. Brownell Jr., and D.K. Mattila. 2015. U.S. Pacific Marine Mammal Draft Stock Assessments: 2014. NOAA Technical memorandum, NOAA-TMNMFS-SWFSC-XXX.
- Cascadia Research Collective. 2011a. Unusual dolphin in southern Puget Sound. <http://www.cascadiaresearch.org/Tursiops-Feb2011.htm>. Accessed May 3, 2013.
- Cascadia Research Collective. 2011b. Long-beaked common dolphins in Puget Sound. <http://www.cascadiaresearch.org/commondolphin2011.htm>. Accessed November 14, 2012.
- CINMS. 2008. Reducing Ship Strikes on Large Cetaceans in the Santa Barbara Channel and Channel Islands National Marine Sanctuary. Channel Islands National Marine Sanctuary Advisory Council. <http://channelislands.noaa.gov/sac/pdf/cpp2-08.pdf>
- Channel Islands National Marine Sanctuary. 2014. Available at: channelislands.noaa.gov/management/resource/regulations.html
- Clapham, P.J. 2009. Humpback whale *Megaptera novaeangliae*. pp 582-585. in W.F. Perrin, B. Würsig, and H.G.M. Thewissen (eds.). *Encyclopedia of Marine Mammals*, Academic Press, San Diego, CA. 1316 pp.
- Clark, C. W., W. T. Ellison, B. L. Southall, L. Hatch, S. M. Van Parijs, A. Frankel, and M. Ponirakis. 2009. Acoustic masking in marine ecosystems: intuitions, analysis, and implications: *Marine Ecology Progress Series*, v. 395, 301-322 pp.
- Collie, J. S., G. A. Escanero, and P. C. Valentine. 2000. Photographic evaluation of the impacts of bottom fishing on benthic epifauna. *ICES Journal of Marine Science*, 57: 987–1001.

- Columbia River Crossing (CRC). 2011. Ecosystems Technical Report for the Final Environmental Impact Statement. May 2001.
- Costelao, R. M., T. P. Mavor, J. A. Barth, and L. C. Breaker. 2006. Sea surface temperature fronts in the California Current System from geostationary satellite observations. *Journal of Geophysical Research* 111, C09026. [doi: 10.1029/2006JC003541]
- Cramer, S.P., J. Norris, P.R. Mundy, G. Grette, K.P. O’Neal, J.S. Hogle, C. Steward, and P. Bahls. 1999. Status of chinook salmon and their habitat in Puget Sound. Volume 2, Final Report. Prepared for Coalition of Puget Sound Businesses. S.P. Cramer & Associates, Inc. Gresham, OR.
- Christidis, L., W. E. Boles. 2008. Systematics and taxonomy of Australian birds. CSIRO Publishing, Collingwood, Australia
- Crone, P. R., K. T. Hill, J. D. McDaniel, and K. Lynn. 2011. Pacific mackerel (*Scomber japonicus*) stock assessment for USA management in the 2011-12 fishing year. Pacific Fishery Management Council, Pacific Fishery Management Council, 7700 NE Ambassador Place, Suite 101, Portland, Oregon 97220, USA. 100 p.
- Cury, P.M., I.L. Boyd, S. Bonhommeau, T. Anker-Nilssen, R.J.M. Crawford, R.W. Furness, J.A. Mills, E.J. Murphy, H. Österblom, M. Paleczny, J.F. Piatt, J-P Roux, L. Shannon, and W.J. Sydeman. 2011. Global seabird response to forage fish depletion – one-third for the birds. *Science* vol. 334 (6063): 1703-1706
- Cuyler, L. C., R. Wiulsrød, and N. A. Øritsland. 1992. Thermal IR Radiation from Free Living Whales, *Marine Mammal Science*, 8(2): 120–134.
- DeLacy, A. C., B. S. Miller, and S. F. Borton. 1972. Checklist of Puget Sound fishes. Wash. Sea Grant, University of Washington, Seattle, WA, No. WSG 72-3. 43 p.
- Denlinger, L.M. 2006. Alaska seabird information series. Unpublished. Rept., U.S. Fish and Wildlife Service. Migratory Bird Management Program, Anchorage, AK.
- Department of Energy (DOE). 2008. Potential environmental effects of marine and hydrokinetic energy technologies. Draft Report to Congress, Prepared in Response to Energy Independence and Security Act of 2007, Section 633(b). Available at: <http://www.ornl.gov/sci/eere/EISARreport/report.html>.
- Department of the Navy (DON). 2008b. Request for letter of authorization for the incidental harassment of marine mammals resulting from Navy training activities conducted within the northwest training range complex. September 2008. 323 pp.
- DON. 2013. Hawaii-Southern California training and testing activities Final Environmental Impact Statement/Overseas Environmental Impact Statement, Vol 1. U.S. Department of the Navy, Pacific Fleet, Pearl Harbor, HI. 936 pp.
- Doeringer, P. B., P. I. Moss and D. G. Terkla. 1986. Capitalism and kinship: do institutions matter in the labor market? *Industrial and Labor Relations Review* 40(1):48-60.
- Donaldson, A., C. Gabriel, B.J. Harvey, and J. Carolsfeld. 2010. Impacts of fishing gears and other than bottom trawls, dredges, gillnets, and longlines on aquatic biodiversity and vulnerable marine ecosystems. Dep. of Fish. and Ocean Canada Res. Doc. 2010:011. 90 p.
- Dotson, R. C., D. A. Griffith, D. L. King, and R. L. Emmett. 2010. Evaluation of a marine mammal excluder device (MMED) for a Nordic 264 midwater rope trawl. U.S. Department of Commerce, NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-455. 19 pp. http://docs.lib.noaa.gov/noaa_documents/NMFS/SWFSC/TM_NMFS_SWFSC/NOAA-TM-NMFS-SWFSC-455.pdf

- Douglas, A.B., J. Calambokidis, S. Raverty, S.J. Jeffries, D.M. Lambourn, and S.A. Norman. 2008. Incidence of ship strikes of large whales in Washington State. *Journal of the Marine Biological Association of the United Kingdom* 88:1121-1132.
- Dow Piniak, W.E., S.A. Eckert, C.A. Harms, and E.M. Stringer. 2012. Underwater hearing sensitivity of the leatherback sea turtle (*Dermochelys coriacea*): Assessing the potential effect of anthropogenic noise. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Headquarters, Herndon, VA. OCS Study BOEM 2012-01156. 35pp.
- Drake, J., E. A. Berntson, J. M. Cope, R. G. Gustafson, E. E. Holmes, P. S. Levin, N. Tolimieri, R. S. Waples, S. Sogard, G. D. Williams. 2010. Status review of five rockfish species in Puget Sound, Washington: Bocaccio (*Sebastes paucispinis*), canary rockfish (*S. pinniger*), yelloweye rockfish (*S. ruberrimus*), greenstriped rockfish (*S. elongatus*), and redstripe rockfish (*S. proriger*). U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-108.
- Eckert, S.A., and J. Lien. 1999. Recommendations for eliminating incidental capture and mortality of leatherback sea turtles, *Dermochelys coriacea*, by commercial fisheries in Trinidad and Tobago. A report to the Wider Caribbean Sea Turtle Conservation Network (WIDECAST). Hubbs-Sea World Research Institute Technical Report No. 2000-310.
- Eckert, K.L., B.P. Wallace, J.G. Frazier, S.A. Eckert, and P.C.H. Pritchard. 2012. Synopsis of the biological data on the leatherback sea turtle (*Dermochelys coriacea*). U.S. Department of Interior, Fish and Wildlife Service, Biological Technical Publication BTP-R4015-2012, Washington, D.C.
- Edds-Walton, P.L. 1997. Acoustic communication signals of mysticete whales. *Bioacoustics* 8:47–60.
- Eigenmann, C.H., and C.H. Beeson, 1894. *Pteropodus dallii* sp. Nov. *Am. Nat.* 28:66.
- Emmett, R.L., et al. 1991. Distribution and abundance of fishes and invertebrates in west coast estuaries, Vol. II: Species life history summaries. ELMR Rep. No. 8. NOAA/NOS SEA Division, Rockville, MD. 329 p.
- Epperly, S., L. Avens, L. Garrison, T. Henwood, W. Hoggard, J. Mitchell, J. Nance, J. Poffenberger, C. Sasso, E. Scott-Denton, and C. Yeung. 2002. Analysis of sea turtle bycatch in the commercial shrimp fisheries of southeast U.S. waters and the Gulf of Mexico. NOAA Technical Memorandum NMFS-SEFSC-490: 1-88.
- Ernst, C., R. Barbour. 1972. *Turtles of the United States*. Lexington, Kentucky, USA: University Press of Kentucky.
- Estes, J.A., J.L. Bodkin, and M. Ben-David. 2009. Otters, Marine. pp 807-816. *In* W.F. Perrin, B. Würsig, and H.G.M. Thewissen (eds.). *Encyclopedia of Marine Mammals*, Academic Press, San Diego, CA. 1316 pp.
- Falcone, E.A., J. Calambokidis, G.H. Steiger, M. Malleson, and J. Ford. 2005. Humpback whales in the Puget Sound/Georgia Strait Region. Proceedings of the 2005 Puget Sound Georgia Basin Research Conference, 29-31 March 2005, Seattle, WA. Proceedings available from Puget Sound Action Team, Olympia, WA (<http://www.psat.wa.gov>).
- Fisher, W.K. (1938). Hydrocorals of the North Pacific Ocean. *Proceedings of the United States National Museum* 84:493-554.
- Ford, J.K.B. 2005. First records of long-beaked common dolphins, *Delphinus capensis*, in Canadian waters. *Canadian Field-Naturalist* 119:110-113.
- Ford, J.K.B. 2009. Killer whale *Orcinus orca*. pp 650-657, *in* W.F. Perrin, B. Würsig, and H.G.M. Thewissen (eds.), *Encyclopedia of Marine Mammals*, Academic Press, San Diego, CA. 1316 pp.

- Forney, K.A., S.R. Benson, and G.A. Cameron. 2001. Central California gillnet effort and bycatch of sensitive species, 1990-98. Pp. 141-160. In E.F. Melvin and J.K. Parrish (eds.). Proceedings – Seabird Bycatch: Trends, Roadblocks, and Solutions. University of Alaska Sea Grant, Ak-SG-01-01, Fairbanks, AK.
- Forney, K.A. 2007. Preliminary estimates of cetacean abundance along the U.S. west coast and within four National Marine Sanctuaries during 2005. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-406. 27 pp.
- Fresh, K.L. 2006. Juvenile Pacific Salmon in Puget Sound. Puget Sound Nearshore Partnership Report No. 2006-06. Published by Seattle District, U.S. Army Corps of Engineers, Seattle, Washington.
- Freiwald, A., J.H. Fossa, A. Grehan, T. Koslow, and M. Roberts. 2004. “Cold-water coral reefs, out of sight – no longer out of mind.” UNEP World Conservation Monitoring Centre. 86p.
- Fresh K., M. Dethier, C. Simenstad, M. Logsdon, H. Shipman, C. Tanner, T. Leschine, T. Mumford, G. Gelfenbaum, R. Shuman, J. Newton. 2011. Implications of observed anthropogenic changes to the nearshore ecosystems in Puget Sound. Prepared for the Puget Sound Nearshore Ecosystem Restoration Project. Technical Report 2011-03. Accessed online at http://www.pugetsoundnearshore.org/technical_papers/implications_of_observed_ns_change.pdf
- Fresh, K., personal communication to Bill Mavros, February 2014
- Gallo, J.P. 1994. Factors affecting the population status of Guadalupe fur seal, *Arctocephalus townsendi* (Merriam, 1897), at Isla de Guadalupe, Baja California, Mexico. Ph.D. Thesis, University of California, Santa Cruz. 199 pp.
- Gaston, A. J., and S. B. C. Dechesne. 1996. Rhinoceros Auklet (*Cerorhinca monocerata*). In A. Poole and F. Gill (eds.). The Birds of North America, No. 212. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists Union, Washington, D.C.
- Gearin, P. J. and J. Scordino. 1995. Marine mammals of the northwest coast of Washington. Unpublished NMFS-NWR report. Available National Marine Mammal Laboratory, 7600 Sand Point Way, NE, Seattle, WA 98115. 26 pages.
- Gillman, E., N. Brothers, G. McPherson, and P. Dalzel. 2006. A review of cetacean interactions with longline gear. Journal of Cetacean Research and Management, 8 (2): 215-223.
- Goetz, F.A., E. Jeanes, and E. Beamer. 2004. Bull trout in the near shore. U.S. Army Corps of Engineers, Seattle District, Seattle, WA.
- Good, T.P., R.S. Waples, and P. Adams (editors). 2005. Updated status of federally listed ESUs of WestCoast Salmon and Steelhead. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-66, 598 p.
- Graber, J., J. Thomson, B. Polagye, and A. Jessup. 2011. Land-based infrared imagery for marine mammal detection. Proceedings of SPIE Vol. 8156. In W. Gao, T. J. Jackson, J. Wang, N.-B. Chang (eds.). Remote Sensing and Modeling of Ecosystems for Sustainability VIII. 81560B.
- Graham, T.R. 2009. Scyphozoan jellies as prey for leatherback sea turtles off central California. Master's Theses. Paper 3692. Available at: http://scholarworks.sjsu.edu/etd_theses/3692
- Graham, T. R., J. T. Harvey, S. R. Benson, J. S. Renfree, and D. A. Demer. 2010. The acoustic identification and enumeration of scyphozoan jellyfish, prey for leatherback sea turtles (*Dermochelys coriacea*), off central California. – ICES Journal of Marine Science, 67: 1739–1748.
- Gustafson, R.G. W.H Lenarz, B.B. McCain, C.C Schmitt, W.S. Grant, T.L.Builder, and R.D. Methot. 2000. Status review of Pacific Hake, Pacific Cod, and Walleye Pollock from Puget

- Sound, Washington. National Marine Fisheries Service, Northwest Fisheries Science Center. NOAA Technical Memorandum NMFS-NWFSC-44.
- Gustafson, R.G., M.J. Ford, D. Teel, and J.S. Drake. 2010. Status review of eulachon (*Thaleichthys pacificus*) in Washington, Oregon, and California. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-105, 360 p.
- Hamer, D. J., S. J. Childerhouse, and N. J. Gales. 2010. Mitigating operational interactions between odontocetes and the longline fishing industry: a preliminary global review of the problem and of potential solutions. IWS SC Paper # SC/62/BC6.
- Hamlet, A.F. and D.P. Lettenmaier. 2007. Effects of climate change on hydrology and water resources in the Columbia River Basin. *Journal of the American Water Resources Association*. 36(6): 1597-1623.
- Hanson, H. B. 2007. Seasonal movements and habitat use of Dall's and harbor porpoises in the inland and coastal waters of Washington State as determined by radio telemetry. Pages 53-54, in Sheridan, P., J. W. Ferguson, and S. L. Downing (eds.). Report of the National Marine Fisheries Service workshop on advancing electronic tag technologies and their use in stock assessments. U.S. Department Commerce, NOAA Technical Memorandum NMFSF/SPO-82, 82 p.
- Hanson, M.B, R.W. Baird, J.K.B. Ford, J. Hempelmann-Halos, D.M. Van Doornik, J.R. Candy, C.K. Emmons, G.S. Schorr, B. Gisborne, K.L. Ayres, S.K. Wasser, K.C. Balcomb, K. Balcomb-Bartok, J.G. Sneva, M.J. Ford. 2010. Species and stock identification of prey consumed by endangered southern resident killer whales in their summer range. *Endangered Species Res* 11:69-82.
- Harley, C.D.G., A.R. Hughes, K.M. Hultgren, B.G. Miner, C.J.B. Sorte, C.S. Thornber, L.F. Rodriguez, L. Tomanek, and S.L. Williams. 2006. The impacts of climate change in coastal marine ecosystems. *Ecology Letters* 9:228-241.
- Harrison, P. J., D. L. Mackas, B. W. Frost, R. W. Macdonald, and E. A. Creclius. 1994. An assessment of nutrients, plankton, and some pollutants in the water column of Juan de Fuca Strait, Strait of Georgia and Puget Sound, and their transboundary transport. *Can. Tech. Rep. Fish. Aquat. Sci.* 1948:138-172.
- Henwood, T. A., and W. Stuntz. 1987. Analysis of sea turtle captures and mortalities during commercial shrimp trawling. *Fishery Bulletin* 85(4):813-817.
- Hewitt, Roger. 1981. Eddies and speciation in the California Current. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Center, La Jolla, CA 92038.
- Hickey, B.M., L.J. Pietrafesa, D.A. Jay, and W.C. Boicourt. 1998. The Columbia River plume study: Subtidal variability in the velocity and salinity fields. *Journal of Geophysical Research* 103(C5):10339-10368.
- Hickey, B.M. and N.S. Banas. 2003. Oceanography of the U.S. Pacific Northwest coastal ocean and estuaries with application to coastal ecology. *Estuaries* 26(4B):1010-1031.
- Hiddink J.G., Jennings S., Kaiser M.J., Queirós A.M., Duplisea D.E., Piet G.J. (2006) Cumulative impacts of seabed trawl disturbance on benthic biomass, production and species richness in different habitats. *Can J Fish Aquat Sci* 63: 721–736
- Hildebrand, J. A., G. L. D'Spain, M. A. Roch, and M. B. Porter. 2009. Glider-based passive acoustic monitoring techniques in the Southern California Region. Office of Naval Research Award Number: N000140811124.

- Hill, K.T., P.R. Crone, N.C.H. Lo, B.J. Macewicz, E. Dorval, J.D. McDaniel, and Y. Gu. 2011. Assessment of the Pacific sardine resource in 2011 for U.S. management in 2012. NOAA-TM-NMFS-SWFSC-487. NOAA, NMFS, SWFSC, La Jolla, CA.
- Hirth, H.F. 1997. Synopsis of the biological data of the green turtle, *Chelonia mydas* (Linnaeus 1758). USFWS Biological Report 97(1).
- Hodge, R. P. and B. L. Wing. 2000. Occurrences of marine turtles in Alaska waters 1960-1998. Herpetological Review 31: 148-151.
- Hoelzel, A.R. 1993. Foraging behavior and social group dynamics in Puget Sound killer whales. Animal Behaviour 45: 581-591.
- Holland, S. M. and R. B. Ditton. 1992. Fishing trip satisfaction: A typology of anglers. *North American Journal of Fisheries Management* 12(1):28-33.
- Horwood, J. 2009. *Sei whale Balaenoptera borealis*. pp 1001-1003, in W.F. Perrin, B. Würsig, and H.G.M. Thewissen (eds.), *Encyclopedia of Marine Mammals*, Academic Press, San Diego, CA. 1316 pp.
- Huang, H.W. 2011. Bycatch of high sea longline fisheries and measures taken by Taiwan: Action and challenges. *Marine Policy* 35: 712-720.
- Huber H.R., S.J. Jeffries, D.M. Lambourn, B.R. Dickerson. 2010. Population substructure of harbor seals (*Phoca vitulina richardsi*) in Washington State using mtDNA. *Can. J. Zool.* 88(3): 280-288.
- Huber H.R., B.R. Dickerson, S. J. Jeffries, and D.M. Lambourn. 2012. Genetic analysis of Washington State harbor seals (*Phoca vitulina richardii*) using microsatellites. *Can. J. Zool.* 90(12): 1361-1369.
- Huggins, J., J. Calambokidis, D. Lambourn, B. Diehl, J. Oliver, S. Jeffries, and S. Raverty. 2011. Tropical cetaceans in southern Puget Sound: anomalous sightings and strandings in Washington State, 2010-2011. Abstract (Proceedings) 19th Biennial Conference on the Biology of Marine Mammals, Tampa, Florida, November 27-December 2, 2011.
- Hutchinson, I. 1988. Estuarine marsh dynamics in the Puget Trough implications for habitat management. In *Proceedings of the first annual meeting on Puget Sound research*, p. 455-462. Puget Sound Water Quality Authority, Seattle, WA.
- Hyrenbach, K. D., and Veit, R. R. 2003. Ocean warming and seabird communities of the southern Californian current system (1987–98): response at multiple temporal scales. *Deep-sea Research. Part II, Topical Studies in Oceanography* 50: 2537–2565.
- International Maritime Organization (IMO). 2010. International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL). Available from: [http://www.imo.org/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-\(MARPOL\).aspx](http://www.imo.org/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx)
- International Union for Conservation of Nature (IUCN). 2014. *puffinus griseus*. Available from: <http://www.iucnredlist.org/details/22698209/0>. Downloaded on May 13, 2014.
- Jameson, R. J. and S. Jeffries. 2010. Results of the 2010 Survey of the reintroduced Sea Otter population in Washington State. Washington Department of Fish and Wildlife, Wildlife Science Program, Marine Mammal Investigations.
- Jannot, J., Heery, E., Bellman, M.A., and J. Majewski. 2011. Estimated bycatch of marine mammals, seabirds, and sea turtles in the U.S. west coast commercial groundfish fishery, 2002-2009. West Coast Groundfish Observer Program. National Marine Fisheries Service, NWFSC, 2725 Montlake Blvd E., Seattle, WA 98112.

- Jefferson, T. and B. Curry. 1996. Acoustic methods of reducing or eliminating marine mammal-fishery interactions: do they work? *Ocean Coast Manage.* 31(1):41-70.
- Jefferson, T. A. 2009. Dall's porpoise *Phocoenoides dalli*. Pages 296-298. *In* W.F. Perrin, B. Würsig, and H.G.M. Thewissen (eds.), *Encyclopedia of Marine Mammals*, Academic Press, San Diego, CA. 1316 pages.
- Jeffries, S.J., P.J. Gearin, H.R. Huber, D.L. Saul, and D.A. Pruett. 2000. Atlas of Seal and Sea Lion Haulout Sites in Washington. Washington Department of Fish and Wildlife, Wildlife Science Division, 600 Capitol Way North, Olympia WA. pp. 150.
- Jeffries, S. and R.J. Jameson. 2015. Results of the 2014 survey of the reintroduced sea otter population in Washington State. Washington Department of Fish and Wildlife, Wildlife Science Program, Marine Mammal Investigations, Lakewood, WA. 8 pp.
- Jennings S., Dinmore T.A., Duplisea D.E., Warr K.J., Lancaster J.E. 2001. Trawling disturbance can modify benthic production processes. *J Anim Ecol* 70:459–475.
- Jensen, A. S. and G. K. Silber. 2003. Large whale ship strike database. U.S. Department of Commerce, NOAA Technical Memorandum. NMFS-OPR-25, 37 pp.
- Kastak D. R., B. J. Southall, R. D. Schusterman, and C. R. Kastak. 2005. Underwater temporary threshold shifts in pinnipeds: effects of noise level and duration. *Journal of the Acoustical Society of America* 118:3154-3163.
- Kastelein R.A., R.Gransier, L. Hoek, and M. Rambags. 2013. Hearing frequency thresholds of a harbor porpoise (*Phocoena phocoena*) temporarily affected by a continuous 1.5 kHz tone. *J. Acoust. Soc. Am.* 134(3): 2286-2292.
- Kastelein, R.A., P. Wensveen, L. Hoek, and J.M. Terhune. 2009. Underwater hearing sensitivity of harbor seals (*Phoca vitulina*) for narrow noise bands between 0.2 and 80 kHz. *J. Acoust. Soc. Am.* 126 (1): 476-483.
- Kasting, N. W., S. A. Adderley, T. Safford, and K. G. Hewlett. 1989. Thermoregulation in Beluga (*Delphinapterus leucas*) and Killer (*Orcinus orca*) whales. *Physiological Zoology*, 62(3): 687-701.
- Kennedy, DM. 2012. Response to the petition from the Center for Biological Diversity, Friends of the Earth, Environmental Defense Center, and Pacific Environment submitted to the Secretary of Commerce through the National Oceanic and Atmospheric Administration (NOAA) on June 6, 2011. Available at: <http://channelislands.noaa.gov/focus/pdf/petitionresponsenoaa2012.pdf>
- Kenyon, K.W. 1981. Sea otter (*Enhydra lutris*). *Handbook of Marine Mammals*, Vol.1 The Walrus, Sea Lions, Fur Seals, and Sea Otter. Academic Press, San Diego, CA. 235 pp.
- Ketten, D. R. 1998. Marine mammal auditory systems: a summary of audiometric and anatomical data and its implications for underwater acoustic impacts. NOAA-TM-NMFS-SWFSC-256. 74 pp.
- Ketten, D. R. and S. M. Bartol. 2005 Functional measures of Sea Turtle hearing. Final report for Office of Naval Research, ONR award No0014-02-1-0510. 4 pp.
- Knowlton, A. R. and S. D. Kraus. 2001. Mortality and serious injury of Northern Right Whales, *Eubalaena glacialis*, in the Western North Atlantic Ocean. *J. Cetacean Res. Manage.* (Special Issue) 2:193-208.
- Kushlan, James A., J. Steinkamp, C. Parsons, J. Capp, M.A. Cruz, M. Coulter, I. Davidson, L. Dickson, N. Edelson, R. Elliot, R. M. Erwin, S. Hatch, S.Kress, R. Milko, S. Miller, K. Mills, R. Paul, R. Phillips, J. E. Saliva, B. Sydeman, J. Trapp, J.Wheeler, and K. Wohl. 2002. Waterbird

- conservation for the Americas: The North American waterbird conservation plan. Version 1, Waterbird Conservation for the Americas. Washington, DC, U.S.A.
- Laidre, K., R.J. Jameson, S.J. Jeffries, R.C. Hobbs, E.C.E. Bowlby, and G.R. Van Blaricom. 2002. Estimates of carrying capacity for sea otters in Washington State. *Wildlife Society Bulletin* 30:1172-1181.
- Laist, D. W., A. R. Knowlton, J. G. Mead, A. S. Collet, and M. Podesta. 2001. Collisions between ships and whales. *Marine Mammal Science*. 17: 35-75.
- Lamont, M. M., J. T. Vita, J. T. Harvey, S. Jeffries, R. Brown, H. H. Huber, R. DeLong, and W. K. Thomas. 1996. Genetic substructure of the Pacific Harbor Seal (*Phoca vitulina richardsi*) off Washington, Oregon, and California. *Marine Mammal Science* 12:402-413.
- Lance, M.M., S.A. Richardson, and H.L. Allen. 2004. Washington state recovery plan for the sea otter. Washington Department of Fish and Wildlife, Olympia. 91 pp.
- Lang, A.R., Weller, D.W., LeDuc, R., Burdin, A.M., Pease, V.L., Litovka, D., Burkanov, V. and Brownell, R.L., Jr. 2011. Genetic analysis of stock structure and movements of gray whales in the eastern and western North Pacific. Paper SC/63/BRG10 presented to the International Whaling Commission Scientific Committee.
- Lazier A, Smith JE, Risk MJ, Schwarcz HP (1999) The skeletal structure of *Desmophyllum cristagalli*: the use of deep-water corals in sclerochronology. *Lethaia* 32:119-130
- Lipsky, J.D. 2009. Right whale dolphins *Lissodelphis borealis* and *L. peronii*. Pages 959-962, *In* W.F. Perrin, B. Würsig, and H.G.M. Thewissen (eds). *Encyclopedia of Marine Mammals*. Academic Press, San Diego, CA. 1316 pages.
- Loughlin, T.R. 1997. Using the phylogeographic method to identify Steller sea lion stocks. Pp. 329-341 *In* A. Dizon, S. J. Chivers, and W. Perrin (eds.). *Molecular genetics of marine mammals, incorporating the proceedings of a workshop on the analysis of genetic data to address problems of stock identity as related to management of marine mammals*. Soc. Mar. Mammal., Spec. Rep. No. 3.
- Lovell, S., S. Steinback, and J. Hilger. 2013. The economic contribution of marine angler expenditures in the United States, 2011. U.S. Dep. Commerce, NOAA Tech. Memo. NMFS-F/SPO-134, 188 p. Available at:
<http://www.st.nmfs.noaa.gov/Assets/economics/publications/AnglerExpenditureReport/2011/pdf/The%20Economic%20Contribution%20of%20Marine%20Angler%20Expenditures%20in%20the%20United%20States%202011.pdf>
- Lower Columbia River Estuary Partnership (LCREP). 2005. Report on the Estuary. Portland, Oregon.
- Lower Columbia River Estuary Partnership (LCREP). 2010. Report on the Estuary. www.lcrep.org
- Lurton, X. and S. DeRuiter. 2011. Sound radiation of sea-floor mapping echosounders in the water column, in relation to the risks posed to marine mammals. *International Hydrographic Review* (November 2011): 7-17.
- Lyle, J. M. and S. T. Willcox. 2008. Dolphin and seal interactions with mid-water trawling in the Small Pelagic Fishery, including an assessment of bycatch mitigation strategies. Australian Fisheries Management Authority, Final Report Project R05/0996. 49pp.
http://www.imas.utas.edu.au/__data/assets/pdf_file/0005/149648/R05_0996_Final-Rep.pdf
- Mackay, A. and S. Northridge. 2006. Dolphin bycatch in the UK bass pair trawl fishery. Presentation to the ATGTRT meeting, Providence, RI, September 20, 2006.

- Manuwal, D. A. and A. C. Thoresen. 1993. Cassin's Auklet (*Ptychoramphus aleuticus*). In A. Poole and F. Gill (eds.). The Birds of North America, No. 50. Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.
- Mate, B., A.L. Bradford, G. Tsidulko, V. Vertyankin, and V. Ilyashenko. 2011. Late-feeding season movements of a western North Pacific gray whale off Sakhalin Island, Russia and subsequent migration into the Eastern North Pacific. Paper SC/63/BRG23 presented to the International Whaling Commission Scientific Committee.
- Melvin, E.F., J.K. Parrish, K.S. Dietrich, and O.S. Hamel. 2001. Solutions to seabird bycatch in Alaska's longline demersal fisheries. Final report to NMFS on research performed by the University of Washington Sea Grant Program in collaboration with the Fishing Vessel Owners Association, the North Pacific Longline Association, NMFS, and the United States Fish and Wildlife Service.
- Miller, B., and S. Borton. 1980. Geographical distribution of Puget Sound fishes: Maps and data source sheets. Vol. 1: Family Petromyzontidae (lampreys) through family Syngnathidae. Vol. 2: Percichthyidae (temperate basses) through family Hexagrammidae (greenlings). Vol. 3: Family Cottidae (sculpins) through family Molidae (molas). Washington Sea Grant Publ., UW Fisheries Research Institute Publ., Seattle, 681 pp. (monograph).
- Miller, D. R., J. G. Williams, and C. W. Simms. 1983. Distribution, abundance and growth of juvenile salmonids off the coast of Oregon and Washington, summer 1980. Fisheries Research 2(1983): 1-17.
- Milligan, S.R., W.V. Holt, R. Lloyd. 2009. Impacts of climate change and environmental factor on reproduction and development in wildlife. Philosophical Transactions of the Royal Society B 364: 3313-3319.
- Mills, K.L., W.J. Sydeman, and P.J. Hodum. 2005. The California Current Marine Bird Conservation Plan. PRBO Conservation Science, Stinson Beach, CA.
- Mohamedali, T., M. Roberts, B. Sackman, and A. Kolosseus. 2011. Puget Sound Dissolved Oxygen Model. Washington State Department of Ecology. Olympia, Washington. 172 p.
- Mooney, T. A., P. E. Nachtigall, and W. W. L. Au. 2004. Target strengths of a nylon monofilament and an acoustically enhanced gillnet: Predictions of biosonar detection ranges. Aquatic Mammals. 30(2): 220-226. <http://www.whoi.edu/page.do?pid=52857>
- Moore J.E., and J.P. Barlow. 2014. Improved abundance and trend estimates for sperm whales in the eastern North Pacific from Bayesian hierarchical modeling. Endang Species Res 25:141-150.
- Morgan, L. E., and R. Chuenpagdee. 2003. Shifting gears addressing the collateral impacts of fishing methods in U.S. waters. PEW Science Series on conservation and the environment. 52 pp.
- Moser, M. L., and S. T. Lindley. 2007. Use of Washington estuaries by subadult and adult green sturgeon. Environmental Biology of Fishes 79:243–253.
- Moyle, P. B., Foley, P. J., and Yoshiyama, R. M. 1992. Status of green sturgeon, *Acipenser medirostris*, in California. Final Report submitted to National Marine Fisheries Service. 11 p. University of California Davis.
- Moyle, P.B., R.M. Yoshiyama, J.E. Williams, and E.D. Wikramanayake. 1995. Fish Species of Special Concern in California. Second edition. Final report to CA Department of Fish and Game, contract 2128IF.
- National Park Service and the U.S. Fish and Wildlife Service. 1993. Memorandum of understanding between the National Park Service and the U.S. Fish and Wildlife Service.

- National Research Council (NRC). 1990. Decline of the Sea Turtles: causes and prevention. National Academy Press, Washington, D.C. 259 pp.
- NRC. 2005. Marine mammal populations and ocean noise: Determining when noise causes biologically significant effects. National Academy Press, Washington, DC. 142 pp.
- National Conference of State Legislatures (NCSL). 2014. Federally Recognized Tribes. Retrieved February 7, 2014. <http://www.ncsl.org/research/state-tribal-institute/list-of-federal-and-state-recognized-tribes.aspx>
- New England Aquarium (NEA). 2010. Climate change and the oceans. Available from: http://www.neaq.org/conservation_and_research/climate_change/climate_change_and_the_ocean_s.php
- Nilsen, E. and J. Morace. 2014. Foodweb transfer, sediment transport, and biological impacts of emerging and legacy organic contaminants in the lower Columbia River, Oregon and Washington, USA: USGS Contaminants and Habitat (ConHab) Project. *Science of the Total Environment*. 484:319-321.
- Nishida, T. and G. McPherson. 2011. Assessment of specialized acoustic pingers to mitigate toothed whales depredation on Japanese tuna longline catches in the Central Pacific. *J. Acoust. Soc. Am.* 129: 2399 <http://dx.doi.org/10.1121/1.3587804>
- National Marine Fisheries Service (NMFS). 1991. Recovery plan for the humpback whale (*Megaptera novaeangliae*). Prepared by the Humpback Whale Recovery Team for the National Marine Fisheries Service, Silver Spring, MD, 105 pp.
- NMFS. 1997. Investigation of Scientific Information on the Impacts of California Sea Lions and Pacific Harbor Seals on Salmonids and on the Coastal Ecosystems of Washington, Oregon, and California. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-NWFSC-28, 172 p. Available at: <http://www.nwfsc.noaa.gov/publications/techmemos/tm28/tm28.htm>
- NMFS. 1998. Recovery plan for the blue whale (*Balaenoptera musculus*). Prepared by Reeves R.R., P.J. Clapham, R.L. Brownell, Jr., and G.K. Silber for the National Marine Fisheries Service, Silver Spring, MD. 42 pp.
- NMFS and USFWS. 1998a. Recovery plan for U.S. Pacific populations of the Leatherback Turtle (*Dermochelys coriacea*). NMFS, Silver Spring, MD. Available at: http://www.nmfs.noaa.gov/pr/pdfs/recovery/turtle_leatherback_pacific.pdf (3-59)
- NMFS. 2004. 69 FR 43338. Authorization for commercial fisheries under the Marine Mammal Protection Act of 1972; Zero Mortality Rate Goal. Final rule.
- NMFS. 2005. 70 FR 1871. Notice of Intent to prepare an EIS to analyze the potential impacts of applying new criteria in guidelines to determine what constitutes a “take” of a marine mammal under the Marine Mammal Protection Act (MMPA) and Endangered Species Act (ESA) as a result of exposure to anthropogenic noise in the marine environment.
- NMFS. 2005b. Revisions to Guidelines for Assessing Marine Mammal Stocks. 24 pp. Available at: <http://www.nmfs.noaa.gov/pr/pdfs/sars/gamms2005.pdf>
- NMFS. 2006. Draft recovery plan for the sperm whale (*Physeter Macrocephalus*). National Marine Fisheries Service, Silver Spring, MD.
- NMFS. 2007a. Columbia River Estuary ESA Recovery Plan Module for Salmon and Steelhead. Prepared for NOAA Fisheries by the Lower Columbia River Estuary Partnership. Accessed online April 3 2013 : <http://www.nwr.noaa.gov/Salmon-Recovery-Planning/ESA-Recovery-Plans/Estuary-Module.cfm>
- NMFS. 2007b. Conservation plan for the eastern Pacific stock of northern fur seal (*Callorhinus ursinus*). National Marine Fisheries Service, Juneau, Alaska. 99 pages + app. (3-50)

- NMFS. 2007c. Species of Concern Fact Sheet: Pinto Abalone. National Marine Fisheries Services.
http://www.nmfs.noaa.gov/pr/pdfs/species/pintoabalone_detailed.pdf
- NMFS. 2007d. Guidance for Social Impact Assessment. U.S. Dept. Commerce, NOAA Instruction 01-111-02. 39 pp. Available at:
<https://reefshark.nmfs.noaa.gov/f/pds/publicsite/documents/procedures/01-111-02.pdf> (3-68)
- NMFS. 2008a. Draft Environmental Impact Statement for Proposed Authorization of the Makah Whale Hunt. Available at: <http://www.nwr.noaa.gov/Marine-Mammals/Whales-Dolphins-Porpoise/Gray-Whales/upload/Makah-DEIS-All.pdf>
- NMFS. 2008b. Recovery plan for Southern Resident Killer Whales (*Orcinus orca*). National Marine Fisheries Service, Northwest Region, Seattle, Washington.
- NMFS. 2008c. Final environmental assessment: Reducing the impact on at-risk salmon and steelhead by California sea lions in the area downstream from Bonneville Dam on the Columbia River, Oregon and Washington. National Marine Fisheries Service, Northwest Region, Portland, OR. 144 pp.
- NMFS. 2008d. White Abalone recovery plan (*Haliotis sorenseni*). National Marine Fisheries Service, Long Beach, CA. 2008. Recovery Plan for the White Abalone.
- NMFS. 2009a. Status review report for Black Abalone (*Haliotis cracherodii* Leach, 1814). NMFS Southwest Region, Long Beach, CA. Available at:
- NMFS. 2009b. Fishing communities of the United States 2006. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-F/SPO-98, 84 pp. Available at:
http://www.st.nmfs.noaa.gov/st5/publication/communities/CommunitiesReport_ALL.pdf
- NMFS. 2009c. Designation of Critical Habitat for the threatened Southern Distinct Population Segment of North American Green Sturgeon: Final Biological Report. October 2009.
http://www.westcoast.fisheries.noaa.gov/publications/protected_species/other/green_sturgeon/g_s_critical_habitat/gschd_finalbiologicalrpt.pdf
- NMFS. 2010a. Recovery plan for the fin whale (*Balaenoptera physalus*). National Marine Fisheries Service, Silver Spring, MD. 121 pp.
- NMFS. 2010b. Final Environmental Assessment: New Regulations to Protect Killer Whales from Vessel Effects in Inland Waters of Washington. National Marine Fisheries Service, Northwest Region, Seattle, WA.
- NMFS. 2011a. Final recovery plan for the sei whale (*Balaenoptera borealis*). National Marine Fisheries Service, Office of Protected Resources, Silver Spring, MD. 107 pp.
- NMFS. 2011b. Environmental Assessment on the effects of NMFS Permitted Scientific Research and Enhancement Activities on Endangered White Abalone (*Haliotis sorenseni*). March 2011.
- NMFS. 2011c. Fisheries economics of the United States. Available at:
https://www.st.nmfs.noaa.gov/economics/publications/feus/fisheries_economics_2011
- NMFS. 2011d. Columbia River Estuary ESA recovery plan module for salmon and steelhead. Prepared for NMFS by the Lower Columbia River Estuary Partnership and PC Trask & Associates, Inc.
- NMFS. 2011e. Critical Habitat for the Southern Distinct Population Segment of Eulachon: Final Biological Report. September 2011.
http://www.westcoast.fisheries.noaa.gov/publications/protected_species/other/eulachon/eulachon-ch-bio-rpt.pdf
- NMFS. 2012a. NOAA Fisheries – Office of Protected Resources webpage. Accessed May 22, 2012 at <http://www.nmfs.noaa.gov/pr/species/fish/>

- NMFS. 2012b. Request for 12 November 2012 to 11 November 2015 Year 3 to 5) Renewal of the Letter of Authorization Under The Marine Mammal Protection Act For Incidental Harrassment of Marine Mammals Resulting From U.S. Navy Training Activities in the Northwest Training Range Complex. Available at:
http://www.nmfs.noaa.gov/pr/pdfs/permits/nwtrc_loa_renewal_application.pdf
- NMFS. 2013a. Critical Habitat of the of the Coho Salmon. Available at:
<http://www.nmfs.noaa.gov/pr/species/criticalhabitat.htm>
- NMFS. 2013b. Status review of the eastern distinct population segment of Steller Sea Lion (*Eumetopias jubatus*). 144pp + Appendices. Protected Resources Division, Alaska Region, National Marine Fisheries Service, 709 West 9th St, Juneau, Alaska 99802.
- NMFS. 2013c. Status of Stocks 2013: Annual Report to Congress on the Status of U.S. Fisheries. Available at: http://www.nmfs.noaa.gov/sfa/fisheries_eco/status_of_fisheries/archive/2013/status_of_stocks_2013_web.pdf
- NMFS. 2013d. Federal recovery outline: Pacific Eulachon southern distinct population segment. National Marine Fisheries Service, Northwest Region, Portland, OR. Available at:
http://www.westcoast.fisheries.noaa.gov/publications/protected_species/other/eulachon/eulachon_recovery_outline_070113.pdf
- NMFS. 2014a. NOAA Fisheries - Office of Protected Resources webpage, accessed February 4, 2014 at Available at: <http://www.nmfs.noaa.gov/pr/>
- NMFS. 2014b. Northwest Fisheries Science Center, Molecular Genetics Projects, Deep Sea Corals. Available online: <http://www.nwfsc.noaa.gov/research/divisions/cb/genetics/corals.cfm>.
- NMFS. 2014c. Fisheries economics of the United States, 2012. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-F/SPO-137, 175p. Available at:
<https://www.st.nmfs.noaa.gov/Assets/economics/documents/feus/2012/FEUS2012.pdf>.
- NMFS. 2014d. Commercial fisheries statistics: annual commercial landings by Group. National Marine Fisheries Service, Office of Science and Technology. Available online at:
<http://www.st.nmfs.noaa.gov/commercial-fisheries/commercial-landings/annual-landings-with-group-subtotals/index>
- NMFS. 2014e. Commercial fisheries statistics, total commercial fishery landings at major U.S. ports summarized by year and ranked by dollar value. National Marine Fisheries Service, Office of Science and Technology. Available online at: <http://www.st.nmfs.noaa.gov/commercial-fisheries/commercial-landings/other-specialized-programs/total-commercial-fishery-landings-at-major-u-s-ports-summarized-by-year-and-ranked-by-dollar-value/index>
- NMFS. 2014f. Reinitiated biological opinion on navy activities on the Northwest training range complex and NMFS's issuance of an MMPA letter of authorization FPR-2014-9069. 433p
- NMFS. 2014g. Designation of Critical Habitat for the Distinct Population Segments of Yelloweye Rockfish, Canary Rockfish, and Bocaccio: Biological Report. November 2014. http://www.westcoast.fisheries.noaa.gov/publications/protected_species/other/rockfish/rockfish_c_h_biological_report.pdf
- NMFS and United States Fish and Wildlife Service (USFWS). 1995. Status reviews for Sea Turtles listed under the Endangered Species Act of 1973. NMFS, Silver Spring, MD.
- NMFS and USFWS. 1998a. Recovery Plan for U.S. Pacific Populations of the Leatherback Turtle (*Dermochelys coriacea*). NMFS, Silver Spring, MD.

- NMFS and USFWS. 1998b. Recovery plan for U.S. Pacific populations of the Olive Ridley Turtle (*Lepidochelys olivacea*). NMFS, Silver Spring, MD. Available at: http://www.nmfs.noaa.gov/pr/pdfs/recovery/turtle_oliveridley.pdf (3-59)
- NMFS and USFWS. 1998c. Recovery plan for U.S. Pacific populations of the Green Turtle (*Chelonia mydas*). National Marine Fisheries Service, Silver Spring, MD.(3-59)
- NMFS and USFWS. 1998d. Recovery plan for U.S. Pacific population of the Loggerhead Turtle (*Caretta caretta*). NMFS, Silver Spring, MD and Portland, OR. (3-59)
- NMFS and USFWS. 1998e. Recovery Plan for U.S. Pacific Populations of the Hawksbill Turtle (*Eretmochelys imbricata*). NMFS, Silver Spring, MD.
- NMFS and USFWS. 2006. Endangered and Threatened Species: Final listing designation for 10 distinct population segments of west coast steelhead. In Federal Register Volume 71, No. 3. January 5, 2006. pages 834-861.
- NMFS and USFWS. 2007. Protected Resources. Olive Ridley Sea Turtle (*Lepidochelys olivacea*). Available at: <http://www.nmfs.noaa.gov/pr/species/turtles/oliveridley.htm>
- National Oceanic and Atmospheric Administration (NOAA). 1993. Final Environmental Impact Statement and Management Plan for the Olympic Coast National Marine Sanctuary. Prepared by the Sanctuaries and Reserves Division Office of Ocean and Coastal Resource Management, National Ocean Service, National Oceanic and Atmospheric Administration, Silver Spring, MD. http://olympiccoast.noaa.gov/library/docs/feis_vol1.pdf
- NOAA. 1997. NOAA Fisheries Strategic Plan. U.S. Department of Commerce. Available at: <http://www.nmfs.noaa.gov/om2/nmfsplan.pdf>
- NOAA. 2005. Protected Resources Division, Final Assessment of NOAA Fisheries Critical Habitat Analytical Review Teams For 12 Evolutionarily Significant Units of West Coast Salmon and Steelhead. August 2005. http://www.westcoast.fisheries.noaa.gov/publications/protected_species/salmon_steelhead/critical_habitat/chart_report/2005_chart_entire_report.pdf
- NOAA. 2006. NOAA NOS NMSP Silver Fox & Manta UAS Evaluation Project. February 13-19, 2006. Upulo Point Airport, Hawi, Hawaii. 8pp. <http://uas.noaa.gov/projects/demos/silverfox/SilverFoxFinalReport.doc>
- NOAA. 2010a. NOAA strategic plan for deep-sea coral and sponge ecosystems: research, management, and international cooperation. Silver Spring, MD: NOAA Coral Reef Conservation Program. NOAA Technical Memorandum CRCP 11. 67 pp.
- NOAA. 2010b. Safety and environmental compliance office (SECO); Summary of applicable statutes, regulations, and guideline [cited 2010 October 6]. Available from: <http://www.seco.noaa.gov/documents/shipSummary.html>
- NOAA. 2010c. National ocean service: contaminants in the environment. Available at: <http://oceanservice.noaa.gov/observations/contam/>
- NOAA. 2010d. Marine protected areas of the United States. Available at: <http://marineprotectedareas.noaa.gov/>
- NOAA. 2012. NOAA National Marine Protected Areas Center, List of National System Sites. Available from: <http://www.mpa.gov/nationalsystem/nationalsystemlist/>
- NOAA. 2013a. National marine protected areas center. List of National System Sites. <http://marineprotectedareas.noaa.gov/nationalsystem/nationalsystemlist/>.

- NOAA. 2013b. Draft guidance for assessing the effects of anthropogenic sound on marine mammals: Acoustic threshold levels for the onset of permanent and temporary threshold shifts. Available at: http://www.nmfs.noaa.gov/pr/acoustics/draft_acoustic_guidance_2013.pdf.
- NOAA. 2013c. Southern Resident Killer Whale satellite tagging program. Site accessed April 2, 2013. Available at: <http://www.nwfsc.noaa.gov/research/divisions/cb/ecosystem/marinemammal/index.cfm>.
- NOAA. 2014a. West Coast Region Groundfish closed areas. Accessed on July 2, 2014 at: http://www.westcoast.fisheries.noaa.gov/fisheries/management/groundfish_closures/groundfish_closed_areas.html.
- NOAA. 2014b. Office of Protected Resources, Sea Turtles. Available at: <http://www.nmfs.noaa.gov/pr/species/turtles/>
- NOAA. 2014c. Pacific Salmonids: major threats and impacts. Accessed online on August 7, 2014 at <http://www.nmfs.noaa.gov/pr/species/fish/salmon.htm>.
- Norman, K., J. Sepez, H. Lazrus, N. Milne, C. Package, S. Russell, K. Grant, R. Petersen Lewis, J. Primo, E. Springer, M. Styles, B. Tilt, and I. Vaccaro. 2007. Community profiles for West Coast and North Pacific fisheries - Washington, Oregon, California, and other U.S. states. U.S. Dep. Commerce, NOAA Tech. Memo. NMFS-NWFSC-85, 602 pp. Available at http://www.nwfsc.noaa.gov/assets/25/6718_01082008_153910_CommunityProfilesTM85WebFinalSA.pdf
- Northridge, S. 2003. Further development of a dolphin exclusion device. Final Report to UK Department for Environment Food and Rural Affairs (DEFRA), Project MF0735.
- Northwest Fisheries Science Center (NWFSC). 2014. Operations Management and Information Staff, pers. comm.
- NWFSC. 2015. Cruise report: Southern resident killer whale and ecosystem survey, March 2015. http://www.nwfsc.noaa.gov/news/features/skw_ecosystem_survey/. Accessed March 6, 2015.
- Nowacek, D. P., L. H. Thorne, D. W. Johnston, and P. L. Tyack. 2007. Responses of cetaceans to anthropogenic noise. *Mammal Review* 37: 81-115.
- Oleson, E.M., J. Calambokidis, E. Falcone, G. Schorr, and J.A. Hildebrand. 2009. Acoustic and visual monitoring of cetaceans along the outer Washington Coast. Technical Report for grant N0002407WX12527. Report # NPS-OC-09-001 issued by Naval Postgraduate School, Monterey, California. 45 pp.
- Olmstead, T. J., M. A. Roch, P. Hursky, M. B. Porter, H. Klinck, D. K. Mellinger, T. Helble, S. S. Wiggins, G. L. D'Spain, and J. A. Hildebrand. 2010. Autonomous underwater glider based embedded real-time marine mammal detection and classification. *The Journal of the Acoustical Society of America* 127(3): 1971-1971.
- Oregon Department of Fish and Wildlife (ODFW). 2008. Oregon Department of Fish and Wildlife Sensitive Species List. Accessed on May 10, 2014 at http://www.dfw.state.or.us/wildlife/diversity/species/docs/SSL_by_taxon.pdf
- ODFW. 2014. Mid-season pink shrimp update. Accessed on April 8May 10, 2014 at http://www.dfw.state.or.us/wildlife/diversity/species/docs/SSL_by_taxon.pdf
- Osborne, R. J. Calambokidis, and E.M. Dorsey. 1988. A guide to marine mammals of greater Puget Sound. Island Publishers, Anacortes, WA.
- Osmek, S., J. Calambokidis, J. Laake, P. Gearin, R. DeLong, J. Scordino, S. Jeffries, and R. Brown. 1996. Assessment of the status of harbor porpoise (*Phocoena phocoena*) in Oregon and Washington

- waters. U. S. Department of Commerce NOAA Technical Memorandum NMFS-AFSC-76. 56 pages.
- Pacific Coast Joint Venture (PCJV). 1994. Joint venture implementation plans, Lower Columbia River. Oregon Wetlands Joint Venture, West Linn, OR. 24 pp.
- Pacific Fishery Management Council (PFMC). 1998. The Coastal Pelagic Species Fishery Management Plan and Amendments. Available at: <http://www.pcouncil.org/coastal-pelagic-species/fishery-management-plan-and-amendments/>
- PFMC. 2003. Pacific Coast Salmon Plan: Fishery Management Plan for Commercial and Recreational Salmon Fisheries off the Coasts of Washington, Oregon, and California and Amendments. <Http://www.pcouncil.org/salmon/fishery-management-plan/current-management-plan/>
- PFMC. 2007. Fishery Management Plan for U.S. West Coast Fisheries for Highly Migratory Species and Amendments. Available at: <http://www.pcouncil.org/highly-migratory-species/fishery-management-plan-and-amendments/>
- PFMC. 2008. Pacific Coast Groundfish Fishery Management Plan for the California, Oregon, and Washington Groundfish Fishery and Amendments. Available at: <http://www.pcouncil.org/groundfish/fishery-management-plan>.
- PFMC. 2012. Review of 2011 Ocean Salmon Fisheries: Stock Assessment and Fishery Evaluation Document for the Pacific Coast Salmon Fishery Management Plan. (Document prepared for the Council and its advisory entities). Pacific Fishery Management Council, 7700 NE Ambassador Place, Suite 101, Portland, Oregon 97220-1384.
- PFMC. 2014a. Status of the Pacific Coast groundfish fishery, Stock Assessment and Fishery Evaluation. Portland, OR. 280 pp. Available at <http://www.pcouncil.org/groundfish/safe-documents/>
- PFMC. 2014b. Status of the Pacific Coast coastal pelagic species fishery, Stock Assessment and Fishery Evaluation. Portland, OR. 94 pp. Available at <http://www.pcouncil.org/coastal-pelagic-species/stock-assessment-and-fishery-evaluation-safe-documents/>
- PFMC. 2014c. Review of 2013 Ocean Salmon Fisheries: Stock Assessment and Fishery Evaluation Document for the Pacific Coast Salmon Fishery Management Plan. (Document prepared for the Council and its advisory entities.) Pacific Fishery Management Council, 7700 NE Ambassador Place, Suite 101, Portland, Oregon 97220-1384.
- Pacific Offshore Cetacean Take Reduction Team (POCTRT). 2009. Recommendations Report. Available at: http://www.nmfs.noaa.gov/pr/pdfs/interactions/poctrt_recommendations2009.pdf
- POCTRT. 2014. Pacific Offshore Cetacean Take Reduction Team meeting, February 4-6, 2014: Long Beach, California. Key Outcomes Memorandum. 17pp.
- Pacific States Marine Fisheries Commission (PSMFC). 2012. Tri-State Dungeness Crab. Available online: <http://www.psmfc.org/program/tri-state-dungeness-crab-tdsc?pid=17>
- Page, G.W., H.R. Carter, and G. Ford. 1990. Numbers of seabirds killed or debilitated in the 1986 Apex Houston oil spill in Central California. *Stud Avian Biol* 14:164-174.
- Palsson, W.A, T.T. Tsou, G.G. Bargmann, R.M. Buckley, J.E. West, M.L. Mills, Y.W. Cheng, and R.E. Pacunski 2009. The biology and assessment of rockfishes in Puget Sound. Washington Department of Fish and Wildlife, Report FPT-09-04
- Patterson, M. 2012. Birding on the Lower Columbia. Available online: <http://www.olderogon.com/visitor-info/entry/birding-on-the-lower-columbia/>

- Perrin, W.F. 2009. Common dolphins *Delphinus delphis* and *D. capensis*. Pages 255-259. In W.F. Perrin, B. Würsig, and H.G.M. Thewissen (eds.). Encyclopedia of Marine Mammals, Academic Press, San Diego, CA. 1316 pages.
- Perry, S.L., D.P. DeMaster, and G.K. Silber. 1999. The great whales: history and status of six species listed as endangered under the U.S. Endangered Species Act of 1973. Marine Fisheries Review, 61:1-74.
- Piatt, J. F., and A. S. Kitaysky. 2002. Tufted Puffin (*Fratercula cirrhata*). In A. Poole and F. Gill (eds.). The Birds of North America, No. 708. The Birds of North America, Inc., Philadelphia, PA.
- Pitcher, K.W., P.F. Olesiuk, R.F. Brown, M.S. Lowry, S.J. Jeffries, J.L. Sease, W.L. Perryman, C.E. Stinchcomb, and L.F. Lowry. 2007. Abundance and distribution of the eastern North Pacific Steller sea lion (*Eumetopias jubatus*) population. Fishery Bulletin 107: 102-115.
- Pollnac, R. B. and J. J. Poggies. 2008. Happiness, well-being and psychocultural adaptation to the stresses associated with marine fishing. Human Ecology Review 15(2):194-200.
- Popper, A. N. and R. R. Fay. 2011. Rethinking sound detection by fishes. Hearing Research 273: 25-36.
- Presidential Proclamation 2416 by Franklin D. Roosevelt, Delivered on July 25, 1940. Published in 5 FR 2677, 54 Stat. 2717.
- Puget Sound Action Team (PSAT). 2007. 2007 Puget Sound Update. Ninth report of the Puget Sound Assessment and Monitoring Program. Puget Sound Action Team. Olympia, Washington. 260 p.
- Puget Sound Partnership (PSP). 2012. State of the Sound Report. Accessed online at http://www.psp.wa.gov/SOS_download.php.
- Puget Sound Partnership (PSP). 2013. State of the Sound Report. Accessed online at http://www.psp.wa.gov/SOS_download.php.
- Prosperity Sound Regional Council (PSRC). 1995. VISION 2020, 1995 Update. Puget Sound Regional Council Seattle, Washington.
- Prosperity Sound Regional Council (PSRC). 2012. Regional Economic Strategy for the Central Puget Sound Region. Available at: <http://www.psrc.org/assets/8558/RegionalEconomicStrategy.pdf>
- Purdy, D.F. 1990. A summary of the physical oceanography of the Pacific northwest coast. OCS Information Report. MMS 91-0003. Camarillo, California: Minerals Management Service, Pacific Outer Continental Shelf Region, U.S. Department of the Interior. 45 pp.
- Quinn, TP. 2005. The behavior and ecology of Pacific salmon and trout. Bethesda, Maryland: American Fisheries Society.
- Richardson, W.J., C.R.J. Green, C.I. Malme, and D.H. Thomson. 1995. Marine Mammals and Noise. San Diego, CA, Academic Press.
- Riedman, M. 1990a. Sea Otters. Monterey Bay Aquarium Foundation. Monterey Bay, CA. 80 pp.
- Rieman, B. E., and J. D. McIntyre . 1993 . Demographic and habitat requirements for conservation of bull trout . U .S . Forest Service General Technical Report INT-302 .
- Ross, P. 1996. Caution urged in the interpretation of trends at nesting beaches. Marine Turtle Newsletter 74:9-10.
- Rowe, S. J. 2007. A review of methodologies for mitigating incidental catch of protected marine mammals. DOC Research & Development Series 83. Science & Technical Publishing, Dept of Conservation, Wellington, NZ. Available at: <http://www.conservation.co.nz/documents/science-and-technical/drds283.pdf>

- Ruser, A., M. Dähne, J. Sundermeyer, K. Lucke, D.S. Houser, J.J. Finneran, J. Driver, I. Pawliczka, T. Rosenberger, U. Siebert. 2014. In-air evoked potential audiometry of grey seals (*Halichoerus grypus*) from the North and Baltic Seas. PLoS ONE 9(3): e90824. doi:10.1371/journal.pone.0090824
- Salo, E.O. 1991. Life history of chum salmon (*Oncorhynchus keta*), p. 231-309. In Groot, C. and L. Margolis (eds.), Pacific Salmon Life Histories. Univ. B.C. Press, Vancouver, B.C., Canada.
- Salvadeo, C.J., D. Lluch-Belda, A. Gómez-Gallardo, J. Urbán-Ramírez, and C.D. MacLeod. 2010. Climate change and a poleward shift in the distribution of the Pacific white-sided dolphin in the northeastern Pacific. Endangered Species Research 11:13-19.
- Sasso, C. R. and S. P. Epperly. 2006. Seasonal sea turtle mortality risk from forced submergence in bottom trawls. Fisheries Research 81:86-88.
- Scheffer V.B., Slipp J.W. (1948). The whales and dolphins of Washington state with a key to the cetaceans of the west coast of North America. Am Midl Nat 39: 257–337.
- Schorr, G.S., E.A. Falcone, J. Calambokidis, and R.D. Andrews. 2010. Satellite tagging of fin whales off California and Washington in 2010 to identify movement patterns, habitat use, and possible stock boundaries. Report prepared under Order No. JG133F09SE4477 to Cascadia Research Collective, Olympia, WA from the Southwest Fisheries Science Center, National Marine Fisheries Service La Jolla, CA 92037 USA 9pp.
- Scordino, J. 2010. West coast pinniped program investigations on California sea lion and Pacific harbor seal impacts on salmonids and other fishery resources. Report to the Pacific States Marine Fisheries Commission. Available at: http://www.psmfc.org/wp-content/uploads/2012/01/expand_pinniped_report_2010.pdf
- Sears, R., and W.F. Perrin. 2009. Blue whale *Balaenoptera musculus*. pp 120-124, in W.F. Perrin, B. Würsig, and H.G.M. Thewissen (eds.). Encyclopedia of Marine Mammals, Academic Press, San Diego, CA. 1316 pp.
- Sedgley, A. 2011. Puget Sound Seabird Survey. Science by Citizens. Seattle Audubon Society. Seattle, WA.
- Shepard, G.S. 1932. Killer whale in slough at Portland, Oregon. J. Mamm. 13(2):171-172. Shared Strategy for Puget Sound. 2005. Draft Puget Sound salmon recovery plan. Volume 1. Shared Strategy for Puget Sound, Seattle, WA.
- Sherman K., P. Celone, S. Adams. 2004. NOAA Fisheries Service's Large Marine Ecosystems Program: Status Report. NOAA Tech Memo NMFS NE 183; 21 p.
- Sherman, K. and G. Hempel (editors). 2008. The UNEP Large Marine Ecosystem Report: A perspective on changing conditions in LMEs of the world's Regional Seas. UNEP Regional Seas Report and Studies No. 182. United Nations Environment Programme. Nairobi, Kenya.
- Shenker, J.M. 1984. Scyphomedusae in surface waters near the Oregon coast, May–August, 1981. Estuarine Coastal Shelf
- Science 19:619–632 Silber, G.K., S. Bettridge, and D. Cottingham. 2009. Report of a workshop to identify and assess technologies to reduce ship strikes of large whales, 8-10 July, 2008, Providence, RI. U.S. Dep. Comm., NOAA Tech. Memo. NMFS-OPR-42. 55 pp. Available at: <http://www.nmfs.noaa.gov/pr>
- Smith, C. and P. M. Clay. 2010. Measuring subjective and objective well-being: analyses from five marine commercial fisheries. Human Organization 69(2):158-168

- Southall, B.J., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene Jr., D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas, and P.L. Tyack. 2007. Marine mammal noise exposure criteria: initial scientific recommendations. *Aquatic Mammals* 33:411-521.
- Southall, B.L., T. Rowles, F. Gulland, R.W. Baird, and P.D. Jepson. 2013. Final report of the Independent Scientific Review Panel investigating potential contributing factors to a 2008 mass stranding of melon-headed whales (*Peponocephala electra*) in Antsohihy, Madagascar
- Southwest Fisheries Science Center (SWFSC). 2013. Draft Programmatic Environmental Assessment for fisheries research conducted and funded by the Southwest Fisheries Science Center. NMFS, La Jolla, CA. 300 pp. Available at: https://swfsc.noaa.gov/uploadedFiles/Divisions/PRD/Administration/Draft_SWFSC_Fisheries_Research_EA_public_release_draft_v2_18Apr2013_bookmarks.pdf
- Spear L. B. and Ainley D. G. 1999. Migration routes of Sooty Shearwaters in the Pacific Ocean. *Condor* 101: 205-218.
- Spotila, J.R., A.E. Dunham, A.J. Leslie, A.C. Steyermark, P.T. Plotkin, and F.V. Paladino. 1996. Worldwide population decline of *Dermochelys coriacea*: are Leatherback Turtles going extinct? *Chelonian Conservation and Biology* 2(2):290-222.
- Stansell, R. J, K. M. Gibbons, and W.T. Nagy. 2010. Evaluation of pinniped predation on adult salmonids and other fish in the Bonneville Dam tailrace, 2008-2010. U.S. Army Corps of Engineers, Portland District, Fisheries Field Unit, Bonneville Lock and Dam, Cascade Locks, OR 97014
- Stansell, R.J., B.K. van der Leeuw, K.M. Gibbons, and W.T. Nagy. 2014. 2014 field report: Evaluation of pinniped predation on adult salmonids and other fish in the Bonneville Dam tailrace, 2014. USACE, Portland District, Fisheries Field Unit, Bonneville Lock and Dam, Cascade Locks, OR. 34 pp.
- Staubitz, W. W., G. C. Bortleson, S. D. Semans, A. J. Tesoriero, and R. W. Black. 1997. Water-quality assessment of the Puget Sound Basin, environmental setting and its implications for water quality and aquatic biota. USGS Water-Resources Investigations Report 97-4013. 76 p.
- Steinback, S., K. Wallmo, and P. M. Clay. 2009. Saltwater sport fishing for food or income in the Northeastern U.S.: Statistical estimates and policy implications. *Marine Policy* 33(1):49–57.
- Stephenson, P. C. and S. Wells. 2008. Evaluation of the effectiveness of reducing dolphin catches with pingers and exclusion grids in the Pilbara trawl fishery. Final report to Fisheries Research and Development Corporation on Project No. 2004/068. Fisheries Research Report No. 173, Department of Fisheries, Western Australia, 44p.
- Stevenson, D., L. Chiarella, D. Stephan, R. Reid, K. Wilhem, J. McCarthy, and M. Pentony. 2004. Characterization of the fishing practices and marine benthic ecosystems of the Northeast U.S. Shelf, and an evaluation of the potential effects of fishing on essential fish habitat. NOAA Tech. Memo. NMFS-NE-181.
- Stewart, I.J. and R.E. Forrest. 2011. Status of the Pacific Hake (Whiting) stock in U.S. and Canadian Waters in 2011. Joint U.S. and Canadian Hake Technical Working Group. Final SAFE document.
- Sydeman, W.J, K.L. Mills, J.A. Santora, S. Thompson. 2009. Seabirds and climate in the California Current - a synthesis of change. *CalCOFI Report*, Vol. 50, 2009.
- Tasker, M.L. and R.W. Furness. 1996. Estimation of food consumption by seabirds in the North Sea. *Seabird/Fish Interactions, with Particular Reference to Seabirds in the North Sea*. G.L.Hunt Jr. and R.W.Furness (eds.). International Council for the Exploration of the Sea, pp.87.

- Taylor, N. A.C, Hicks, I.G. Taylor, C. Grandin, and S. Cox. 2014. Status of the Pacific Hake (whiting) stock in U.S. and Canadian waters in 2014 with a management strategy evaluation. International Joint Technical Committee for Pacific Hake. Available at: http://www.pcouncil.org/wp-content/uploads/Hake_2014_Assessment.pdf
- Tillin et al. 2006 Chronic bottom trawling alters the functional composition of benthic invertebrate communities on a sea-basin scale. *Marine Ecology Progress Series*. Vol. 318: 31–45, 2006
- Teachout, E., USFWS Biologist Western Washington Office, Lacey, WA. 2013. Personal communication with URS Biologist on March 6 and April 4.
- Thomas A.C. and P.T. Strub, 2001, Cross-shelf phytoplankton pigment variability in the California Current. *Cont. Shelf Res.* 21: 1157-1190
- Thompson , C.W., Wilson, M.L., Pierce, D.J. and Deghetto, D. 1998. Population characteristics of Common Murres and Rhinoceros Auklets entangled in gillnets in Puget Sound, Washington, from 1993 to 1994. *Northwestern Naturalist* 79:77–91.
- Toth, J. F. and R. B. Brown. 1997. Racial and gender meanings of why people participate in recreational fishing. *Leisure Sciences* 19(2), 129 - 146.
- United States Army Corps of Engineers (USACE). 1989. Columbia River and Tributaries Review Study: Project Data and Operating Limits, North Pacific Division, CRT 69. Available at <http://www.nwd-wc.usace.army.mil/TMT/basin.html>. Accessed March 24, 2013.
- United States Army Corps of Engineers (USACE) 2014. Draft Environmental Assessment. Caspian Tern Nesting Habitat Reduction on East Sand Island, Clatsop County, Oregon. U.S. Army Corps of Engineers, Portland District.
- USDOC (U.S. Department of Commerce). 2010. Bureau of Economic Analysis. Gross Domestic Product by State. <<http://www.bea.gov/iTable/iTable.cfm?ReqID=70&step=1&isuri=1&acrdn=1>>
- United States District Court. 1974. The Boldt Decision. Hon. George H. Boldt. Civ. No. 9213
- United States District Court for The Western District of Washington, Tacoma Division 384 F. Supp. 312; 1974 U.S. Dist. LEXIS 12291. February 12, 1974
- U.S. Department of Labor (USDOL). 2014. Bureau of Labor Statistics database. Retrieved February 6, 2014. <http://www.dol.gov/dol/topic/statistics/index.htm>
- U.S. Fish and Wildlife Service (USFWS). 1985. Recovery Plan for the California least tern, *Sterna antillarum browni*. Portland, OR. 112 pp.
- USFWS. 1993. Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for the Pacific Coast Population of the Western Snowy Plover. *Federal Register* Volume 58, No 42. Friday March 5, 1993.
- USFWS. 1997a. Recovery plan for the threatened marbled murrelet (*Brachyramphus marmoratus*) in Washington, Oregon, and California. Portland, Oregon. 203 pp.
- USFWS. 1997b. Synopsis of the biological data on the green turtle, *Chelonia mydas* (Linnaeus 1758). Biological Report 97(1). U.S. Fish and Wildlife Service, Washington, DC.
- USFWS. 1999. Changes in Productivity and Environmental Contaminants in Bald Eagles Nesting along the Lower Columbia River, Final Report. 1999. Portland Oregon <http://www.fws.gov/pacific/ecoservices/envicon/pim/reports/Portland/Bald%20Eagle.htm>
- USFWS. 2003. Final Revised Recovery Plan for the Southern Sea Otter (*Enhydra lutris nereis*). Available at: http://ecos.fws.gov/docs/recovery_plan/030403.pdf

- USFWS. 2005. Regional Seabird Conservation Plan, Pacific Region. U.S. Fish and Wildlife Service, Migratory Birds and Habitat Programs, Pacific Region. Portland, Oregon.
- USFWS. 2006. California least tern (*Sterna antillarum browni*), 5-year review summary and evaluation. Carlsbad Fish and Wildlife Office, Carlsbad, CA. 35 pp.
- USFWS. 2007. Washington Islands National Wildlife Refuges - Flattery Rocks, Quillayute Needles, and Copalis National Wildlife Refuges Comprehensive Conservation Plan and Environmental Assessment. U.S. Fish and Wildlife Service, June 2007. Available at: <http://www.fws.gov/pacific/planning/main/docs/WA/docswaislands.htm>
- USFWS. 2008a. Short-tailed Albatross Recovery Plan. Anchorage, AK, 105 pp.
- USFWS. 2008b. Bull trout (*Salvelinus confluentus*) 5-year review: Summary and evaluation. U.S. Fish and Wildlife Service, Portland, OR
- USFWS. 2009a. Short-tailed albatross (*Phoebastria albatrus*), 5-year review: summary and evaluation. Anchorage, AK, 78 pp.
- USFWS. 2009b. Spotlight Species Action Plan (2010-2014) California least tern. Pacific Southwest Region (Region 8). Carlsbad Fish and Wildlife Office.
- USFWS. 2010. Withdrawal of Proposed Rule To List the Southwestern Washington/Columbia River Distinct Population Segment of the Coastal Cutthroat Trout as Threatened. Federal Register
- USFWS. 2011. Species Profile for Marbled murrelet (*Brachyramphus marmoratus*) Available online: <http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B08C>
- USFWS. 2012a. Final Supplemental Environmental Impact Statement on the Translocation of Southern Sea Otters. Ventura Fish and Wildlife Office, Ventura, California. 348 pp. + front matter and appendices.
- USFWS. 2012b. Western Snowy Plover Species Profile. Available online: <http://www.fws.gov/arcata/es/birds/WSP/plover.html>
- USFWS. 2012c. Common Murre Project, San Francisco Bay National Wildlife Refuge Complex, Fish and Wildlife Service Accessed on May 5, 2014 at <http://www.fws.gov/sfbayrefuges/Murre/index.htm>.
- USFWS. 2014. Revised draft recovery plan for the coterminous United States population of bull trout (*Salvelinus confluentus*). Portland, Oregon. xiii + 151 pp.
- U.S. Geological Survey (USGS). 2011. An evaluation of the science needs to inform decisions on Outer Continental Shelf energy development in the Chukchi and Beaufort Seas, Alaska: U.S. Geological Survey Circular 1370, Holland-Bartels, L., and Pierce, B., eds. 278 pp. <http://pubs.usgs.gov/circ/1370/pdf/circ1370.pdf>
- Urbán, R. J., D. Weller, O. Tyurneva, S. Swartz, A. Bradford, Y. Yakovlev, O. Sychenko, N.H. Rosales, A. S. Martínez, A. Burdin, and U.A. Gómez-Gallardo. 2013. Report on the photographic comparison of the Sakhalin Island and Kamchatka Peninsula with the Mexican gray whale catalogues. Paper SC/65a/BRG04 presented to the International Whaling Commission Scientific Committee.
- Vanderlaan, A.S.M. and C. Taggart. 2007. Vessel collisions with whales: the probability of lethal injury based on vessel speed. Marine Mammal Science 23: 144-156.
- Varoujean, D.H. and W.A. Williams. 1995. Abundance and distribution of marbled murrelets in Oregon and Washington based on aerial surveys. USDA Forest Service Gen. Tech. Rep. PSW-152.

- Veit, R.R., P. Pyle, and J.A. McGowan, J.A. 1996. Ocean warming and long-term change in pelagic bird abundance within the California Current System. *Marine Ecology Progress Series* 139(11–18).
- Veltre, D. W. and M. J. Veltre. 1983. Resource utilization in Unalaska, Aleutian Islands, Alaska. Alaska Dept. of Fish & Game, Division of Subsistence (Bethel, Alaska).
- Wang, J., J. Barkan, S. Fisler, C. Godinez-Reyes, and Y. Swimmer. 2013. Developing ultraviolet illumination of gillnets as a method to reduce sea turtle bycatch. *Biology Letters* 9: <http://dx.doi.org/10.1098/rsbl.2013.0383>
- Wartzok, D., and D.R. Ketten. 1999. Marine mammal sensory systems. pp 117-175, in Reynolds, J.E. III, and S.A. Rommel, editors. *Biology of Marine Mammals*. Smithsonian Institution Press, Washington, D.C.
- Wallace, J., and J.M. Cope. 2011. Status update of the U.S. canary rockfish resource in 2011. National Marine Fisheries Service Northwest Fisheries Science Center. Available at: http://www.pcouncil.org/wp-content/uploads/Canary_2011_Assessment_Update.pdf
- Washington Department of Fish and Wildlife (WDFW). 2001. Washington and Oregon Eulachon Management Plan. WDFW, ODFW. Olympia, Washington
- Washington Department of Fish & Wildlife (WDFW). 2011. Final Puget Sound rockfish conservation plan. Policies, strategies and actions including preferred range of actions. Olympia, WA. March 2011.
- Washington Department of Fish and Wildlife (WDFW) 2012. Tufted Puffin – 2012 Annual Report. Accessed on May 10, 2014 at http://wdfw.wa.gov/conservation/endangered/species/tufted_puffin.pdf.
- Washington Department of Fish and Wildlife (WDFW). 2014. Washington State Species of Concern Lists. Accessed on May 10, 2014 at <http://wdfw.wa.gov/conservation/endangered/>.
- Weller, D.W., A. Klimek, A.L. Bradford, J. Calambokidis, A.R. Lang, B. Gisborne, A.M. Burdin, W. Szaniszló, J. Urbán, A. Gómez-Gallardo Unzueta, S. Swartz, and R.L. Jr. Brownell. 2012. Movements of gray whales between the western and eastern North Pacific. *Endangered Species Research* 18(3):193-199.
- Wells, R.S., and M.D. Scott. 2009. Common bottlenose dolphin *Tursiops truncatus*. Pages 249-255, in W.F. Perrin, B. Würsig, and H.G.M. Thewissen (eds.), *Encyclopedia of Marine Mammals*, Academic Press, San Diego, CA. 1316 pages.
- Werner, F.E. and B.M. Hickey. 1983. The role of a longshore pressure gradient in Pacific Northwest coastal dynamics. *Journal of Physical Oceanography* 13:395-410.
- Whitehead, H. 2009. Sperm whale *Physeter macrocephalus*. pp 1093-1097, in W.F. Perrin, B. Würsig, and H.G.M. Thewissen (eds.), *Encyclopedia of Marine Mammals*, Academic Press, San Diego, CA. 1316 pp.
- Whitmire, C. E., and M.E. Clarke. 2007. State of deep coral ecosystems of the U.S. Pacific Coast: California to Washington. In S. E. Lumsden, T. F. Hourigan, A. W. Bruckner, & G. Dorr (Eds.), *The State of Deep Coral Ecosystems of the United States* (pp. 109-154). Silver Spring, MD: NOAA.
- Williams R, M. Krkošek, E. Ashe, T.A. Branch, S. Clark. 2011. Competing Conservation Objectives for Predators and Prey: Estimating Killer Whale Prey Requirements for Chinook Salmon. *PLoS ONE* 6(11): e26738. doi:10.1371/journal.pone.0026738 Under the Wilderness Act of 1964, 16 USC 1131 et seq; chpt 3 pg 13

- Witherington, B., R. Herren, and M. Bresette. 2006. *Caretta caretta* – Loggerhead sea turtle. Chelonian Res. Monographs 3:74-89.
- Wright, BE, MJ Tennis, and RF Brown. 2010. Movements of male California sea lions in the Columbia River. Northwest Science 84: 60-72.
- Wynne, K. and M. Schwartz. 1999. Guide to marine mammals and turtles of the U.S. Atlantic and Gulf of Mexico. Rhode Island Sea Grant, Narragansett, RI.
- Zamon, JE, TJ Guy, K Balcomb, and D Ellifrit. 2007. Winter Observations of Southern Resident Killer Whales (*Orcinus orca*) near the Columbia River Plume during the 2005 Spring Chinook Salmon (*Oncorhynchus tshawytscha*) Spawning Migration. Northwestern Naturalist 88 (3): 193-198.
- Zollett, E. A. 2005. A review of cetacean bycatch in trawl fisheries. Literature review prepared for the Northeast Fisheries Science Center. Available at: http://nero.noaa.gov/prot_res/atgtrp/ai/gr/16.pdf
- Zug, G.R., and J.F. Parham. 1996. Age and growth in leatherback turtles, *Dermochelys coriacea* (Testudines: Dermochelyidae): a skeletochronological analysis. Chelonian Conservation Biology 2(2):244-249.

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[Note: This work was primarily completed by consultants from URS Corporation in Anchorage, Alaska. In October 2014, URS was purchased by AECOM, Inc. and the final stages of the project were completed by some of the listed personnel as AECOM staff, although the service contract remained under the URS name.]

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APPENDICES

LIST OF APPENDICES

Appendix A – Descriptions of NWFSC research gear and research vessels

Appendix B – Spatial and temporal distribution of NWFSC fisheries research effort by gear type

Appendix C – NWFSC application for regulations and subsequent Letters of Authorization for incidental take of small numbers of marine mammals under the MMPA.

Appendix D – Handling procedures for incidental catch of protected species during NWFSC research

Appendix E - Additional information on hook and line survey in Channel Islands National Marine Sanctuary

